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An Assessment of Five Upper Fraser River Chinook Salmon Sport Fisheries, 1987

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by

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ABSTRACT

Schubert, N.D. 1989. An assessment of five upper Fraser River chinook salmon sport fisheries, 1987. Can. MS Rep. Fish. Aquat. Sci. 1983: 59p.

The retention of chinook salmon (**Oncorhynchus tshawytscha**) adults in Fraser River system sport fisheries was eliminated in 1980 in response to escapement declines. By 1986, improved escapements permitted the reopening of sport fisheries for chinook adults in four upper Fraser River tributaries. In 1987, chinook fisheries were opened in the Bowron, Bridge, Clearwater, Quesnel, Shuswap and South Thompson rivers. The fisheries were regulated through harvest ceilings, time and area restrictions and daily and annual angler harvest limits of one and ten. With the exception of the Clearwater River, each fishery was evaluated using either a roving or a hybrid on-site survey.

A total of 2,001 angler interviews were obtained in the five study areas. An estimated 20,393 angler hours were expended to harvest an estimated 503 chinook adults, 14 chinook jacks, 126 rainbow trout, 237 Dolly Varden char and 38 whitefish. Estimated releases totaled 8 chinook adults, 86 rainbow trout, 3 steelhead trout, 26 Dolly Varden char, 38 whitefish and 10 squawfish. Thirty-one of the harvested chinook adults were marked with adipose fin clips.

The study identified and discussed biases associated with the daily angler harvest limit of one per day and with estimates of daily effort profiles derived from angler interviews.

Key words: upper Fraser River, sport fisheries, chinook salmon, angler effort, harvest, release, bias.

RÉSUMÉ

Schubert, N.D. 1989. An assessment of five upper Fraser River chinook salmon sport fisheries, 1987. Can. MS Rep. Fish. Aquat. Sci. 1983: 59p.

En 1980, il a été interdit aux pêcheurs sportifs de garder les saumons quinnats (**Oncorhynchus tshawytscha**) adultes capturés dans le systeme du fleuve Fraser par suite du déclin des échappées. En 1986, on a pu réouvrir la pêche sportive dans quatre affluents de la partie supérieure du fleuve Fraser. En 1987, la pêche sportive était ouverte dans les rivières Bowron, Bridge, Clearwater, Quesnel, Shuswap et South Thompson. Les périodes d'ouverture ont été réglementées par l'adoption de plafonds pour les prises, de limites de temps et de secteurs, et des limites de prises quotidiennes et annuelles pour les pêcheurs sportifs d'un et de dix saumons respectivement. A l'exception de la rivière Clearwater, chaque pêcherie a été évaluée en fonction d'une levée itinérante ou d'une levée hybride sur place.

Dans les cinq zones expérimentales, on a interviewé un total de 2 001 pêcheurs sportifs. La pêche sportive de 503 quinnats adultes, 11 quinnats mâles précoces, 126 truites arc-en-ciel, 237 Dolly Varden et 38 corégones a exigé, selon les estimations, 20 540 heures de pêche. Les remises à l'eau totales comprenaient 8 quinnats adultes, 86 truites arc-en-ciel, 3 truites steelhead, 26 Dolly Varden, 38 corégones et 10 sauvagesses du nord. Trente-et-un quinnats adultes capturés ont été marqués par rognage de la nageoire adipeuse.

Dans ce document, on a identifié et évalué les distorsions liées à la limite quotidienne d'un poisson par jour imposée aux pêcheurs sportifs et aux estimations des profils d'efforts des pêcheurs sportifs interviewés.

Mots-clés: partie supérieure du fleuve Fraser, pêches sportives, saumon quinnat, effort de pêche sportive, exploitation, remise à l'eau, distorsions.

INTRODUCTION

The harvest of chinook salmon (**Oncorhynchus tshawytscha**) adults in Fraser River sport fisheries was eliminated in 1980 as one of several measures intended to increase chinook escapements. In 1986, sport fisheries for chinook salmon adults were permitted in four upper Fraser River tributaries where escapements were increasing at a rate faster than expected and where harvest could be restricted to single stocks (Schubert 1988). Each fishery was managed to an individual harvest ceiling through regulation of fishing time and daily and annual angler harvest.

In 1987, sport fisheries were opened for the second consecutive year in the Bowron, Clearwater, Quesnel and Shuswap rivers, with fishing times or areas expanded over 1986 in all but the Shuswap River. Additional fisheries were opened in the South Thompson River and at the Bridge River outlet (Fig. 1). In most areas, structured assessment studies monitored fishery performance, evaluated stock impacts and provided data upon which future management decisions could be based.

This report describes the study design and field procedures and documents the results of the 1987 sport fishery assessment studies in the Bowron, Bridge, lower Quesnel, lower Shuswap and South Thompson rivers. The report presents estimates of angler effort, harvest and release by species and angler attributes in each fishery, and concludes with a discussion of results and recommendations for the management and assessment of future fisheries.

STUDY AREA DESCRIPTION

BOWRON RIVER

The Bowron River arises in the Cariboo Mountains of central British Columbia and flows in a northwesterly direction for approximately 230 km, entering the Fraser River 50 km east of Prince George (Fig. 2). The 1986 open area between the Bowron Forest Road and Highway 16 bridges (60 km) was expanded in 1987 to include a section between the Highway 16 and Haggen Creek bridges (55 km). The upper area was accessible from the Beaver, Bowron and Willow forest roads and by boat.

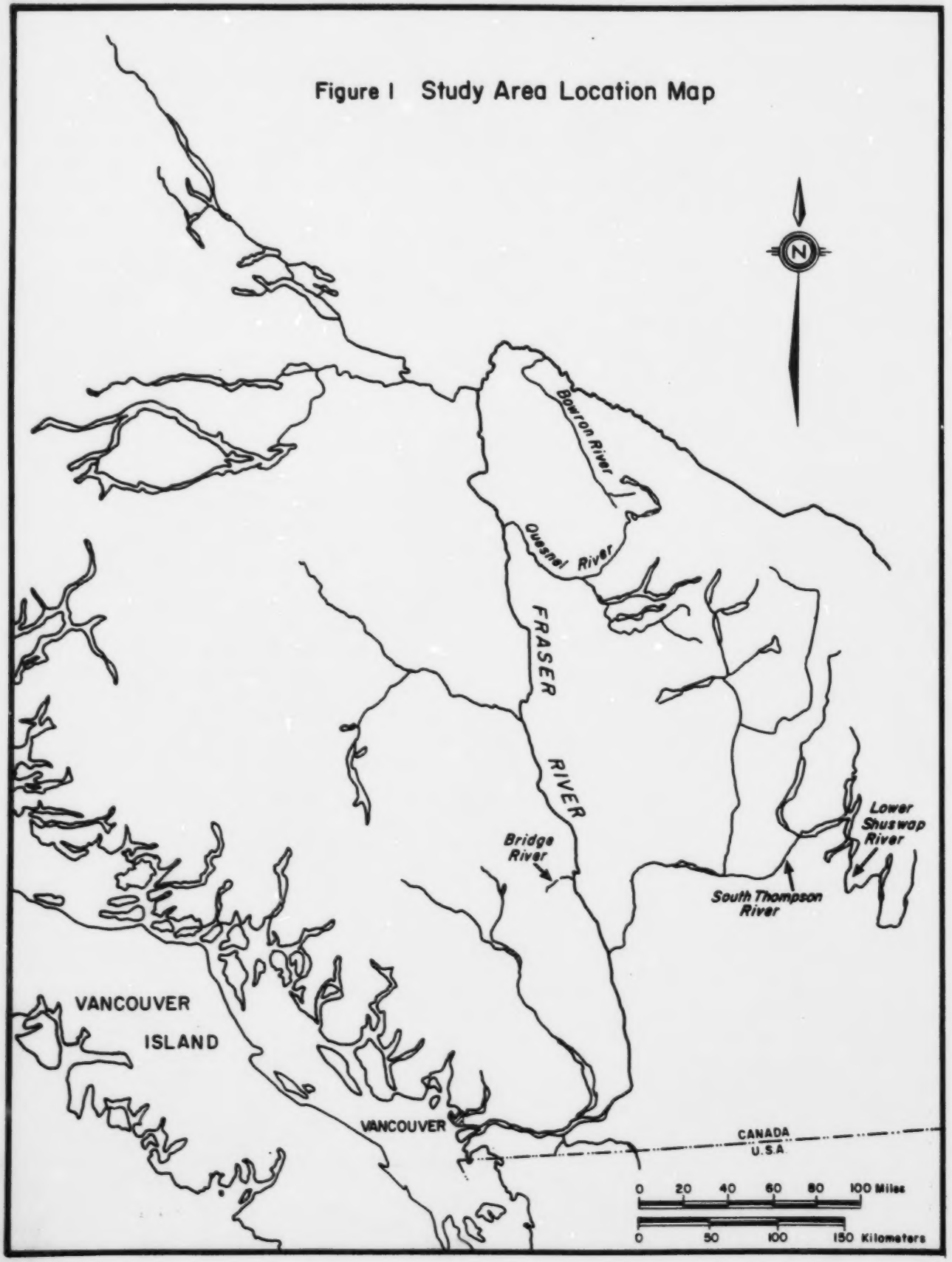
BRIDGE RIVER

The Bridge River originates in the Coast Mountains of southwestern British Columbia and flows in an easterly direction for approximately 140 km, entering the Fraser River approximately 6 km north of Lillooet (Fig. 1). Chinook sport fishing was permitted in a 200 m section of the Bridge River immediately above the confluence with the Fraser River. This area was accessible from a road by traversing land owned by the Bridge River Indian Band. Chinook adults from most upper Fraser River stocks were available to the sport fishery prior to migrating past the Bridge River Rapids, immediately upstream on the Fraser River.

QUESNEL RIVER

The Quesnel River originates in the Cariboo Mountains and flows in a northwesterly direction, entering the Fraser River at Quesnel (Fig. 3). The 1986 open area between Quesnel Lake and the Cariboo River (15 km) was expanded in 1987 to include a section between the Cariboo River and Morehead Creek (10 km) and a section from Beaver Creek to the Fraser River (57 km). The area between Beaver Creek and the Fraser River was accessible by boat and from two roads, one to the north in the lower 15 km, the other to the south from km 23 to Beaver Creek.

Figure 1 Study Area Location Map



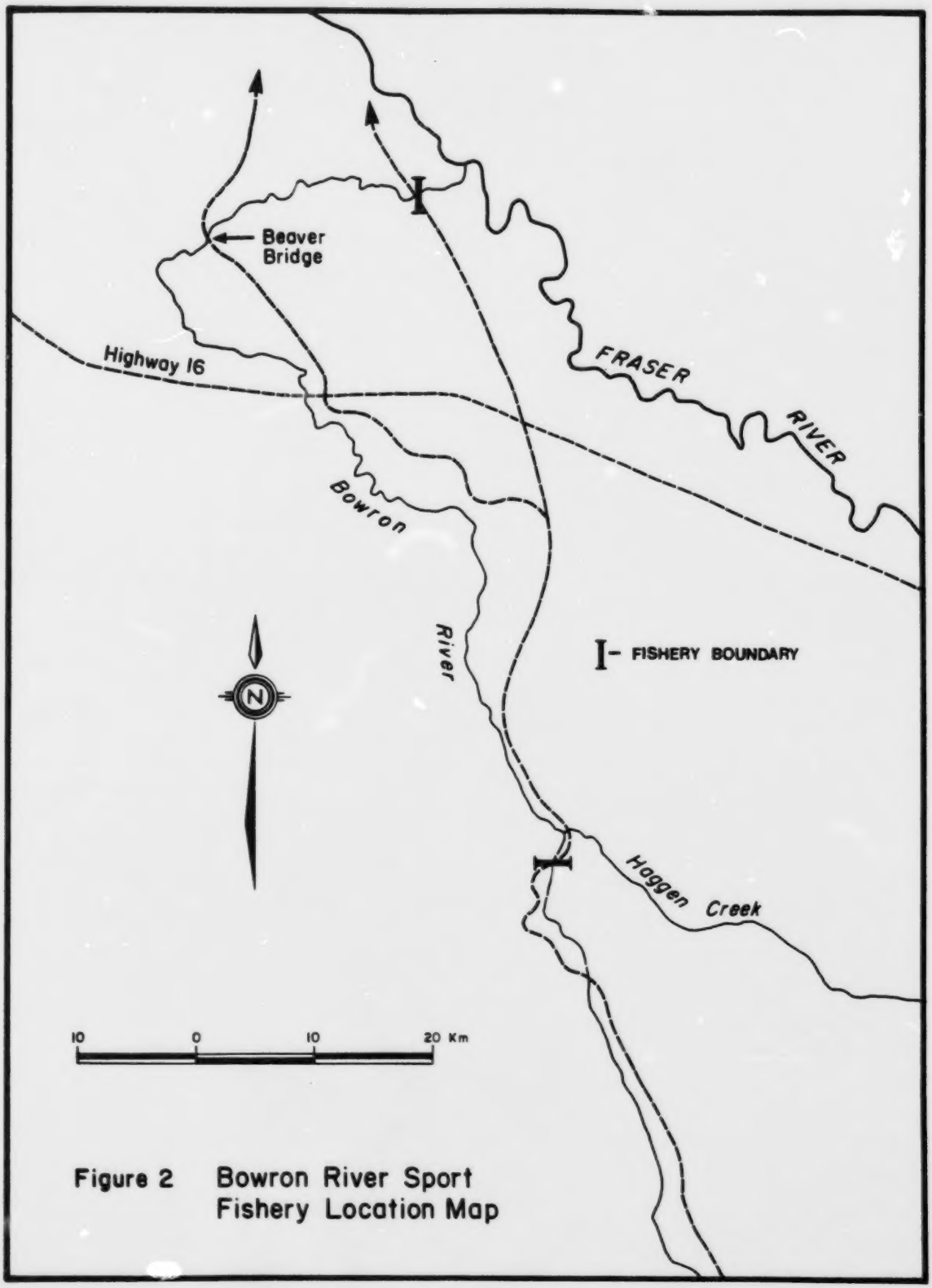


Figure 2 Bowron River Sport Fishery Location Map

Figure 3 Quesnel River Sport Fishery Location Map

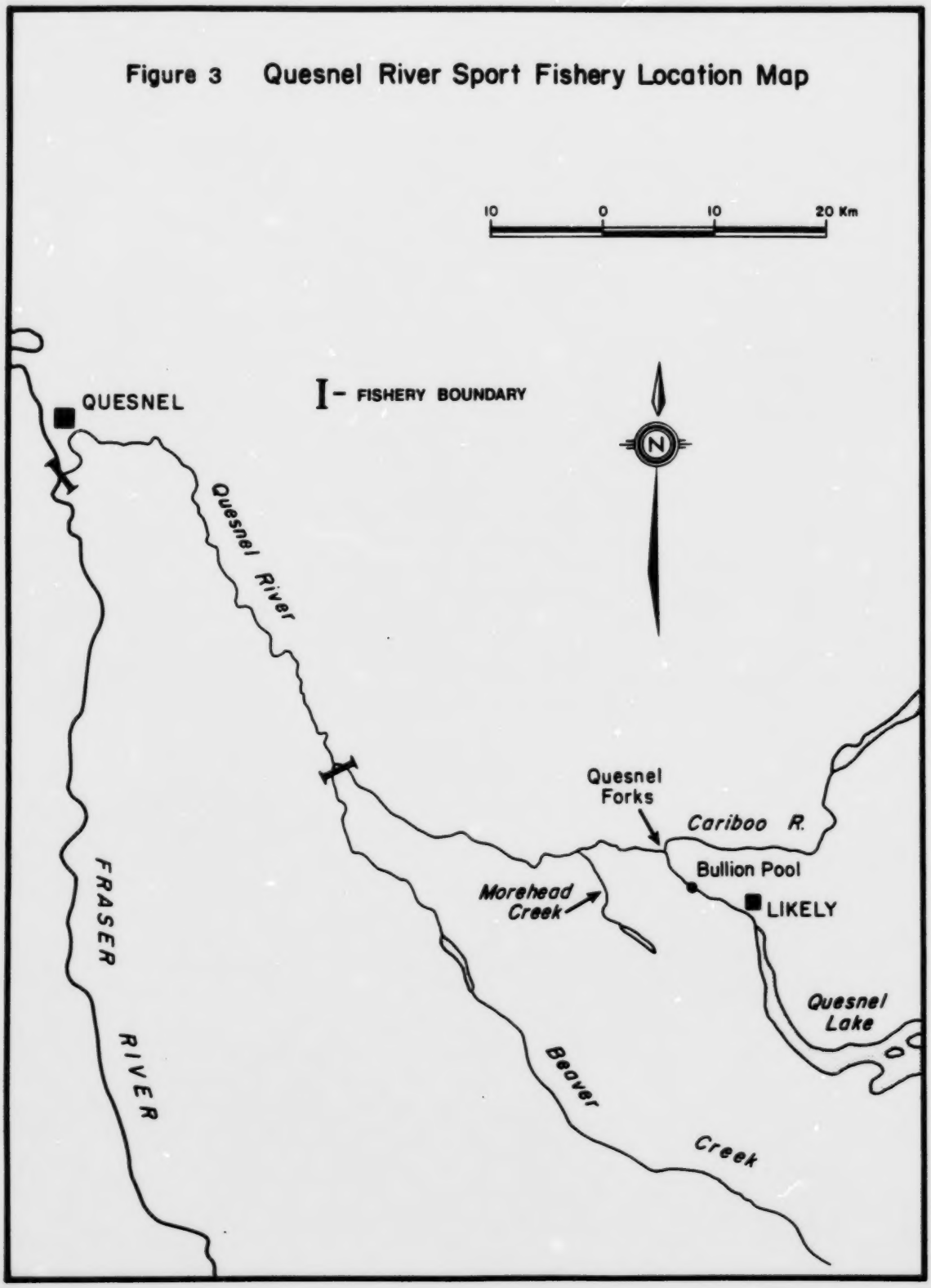


Table 1. Summary of 1987 sport fishery regulations in the five upper Fraser River study areas.

Location	Open Period	Angler harvest limits		Days open per week	Total days open	Harvest ceiling
		Daily	Annual			
Bowron River	Jul 25 to Aug 09	1	10	7	16	300
Bridge River	May 12 to Jul 31	1	10	1-2[a]	15	300
Quesnel River, lower	Jul 14 to Aug 15	1	10	2	9	200
Shuswap River, lower	Sep 01 to Sep 22	1	10	2	7	500
South Thompson River	Sep 10 to Sep 25	1	10	2	5	300

[a] Twelve-hour open periods.

SHUSWAP RIVER

The Shuswap River originates in the Monashee Mountains of south-central British Columbia and flows in a northwesterly direction, entering Mara Lake east of Salmon Arm (Fig. 4). Chinook sport fishing was permitted in the lower Shuswap River between Mara and Mabel lakes. This area was accessible from a number of roads and by boat. Because sport fishing was permitted only in September, lower Shuswap River chinook salmon were the only stock available to the fishery.

SOUTH THOMPSON RIVER

The South Thompson River originates at Little Shuswap Lake in south-central British Columbia and flows in a westerly direction for 65 km, entering the Thompson River at Kamloops (Fig. 1). Chinook sport fishing was permitted between the Chase and Pritchard bridges (18 km) (Fig. 5). The open area was accessible by road and boat. The fishery was open during the peak migration of South Thompson River chinook; however, other South Thompson system chinook stocks may also have been available to the sport fishery.

FISHERY REGULATIONS

In general, the 1987 sport fisheries were managed in a manner similar to 1986 (Schubert 1988), with fishing time restricted in both total duration and days open per week, daily and annual angler harvest limits of one and ten, and fishery-specific harvest ceilings. Regulations are summarized by fishery in Table 1.

METHODS

STUDY DESIGN

Bowron River

The Bowron River sport fishery was assessed, using a hybrid design (Schubert 1988), between July 25 and August 9, 1987. Three surveyors worked one of two eight hour shifts (6:00 AM to 2:00 PM; 1:00 PM to 9:00 PM) which encompassed all daylight hours. The study period was stratified into weekday and weekend/holiday day types. The sampling schedule included all weekend/holiday days and three weekdays per week. Surveyors were stationed at access points to Beaver Bridge and Haggen Creek, the sites of maximum expected angler

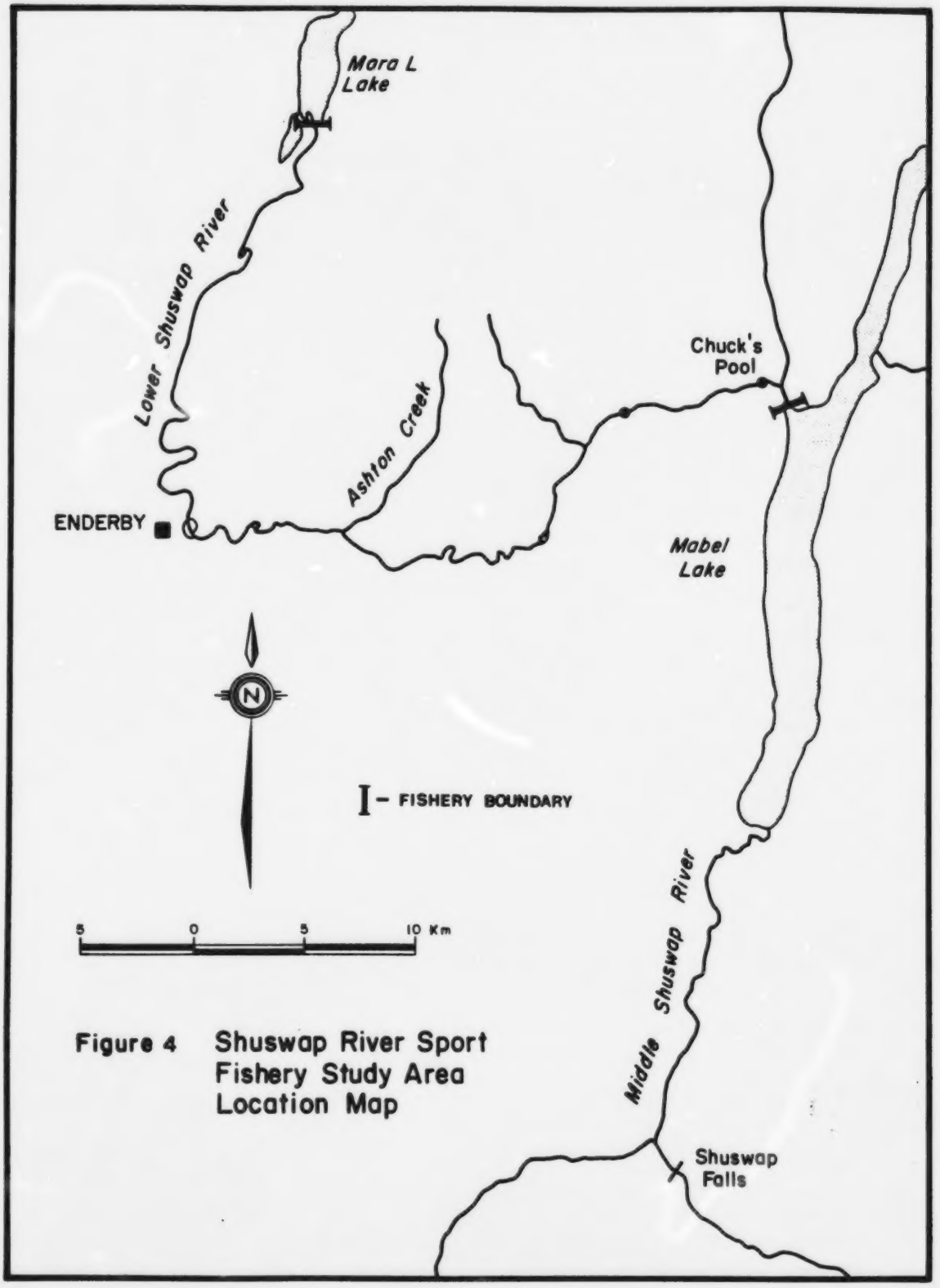


Figure 4 Shuswap River Sport Fishery Study Area Location Map

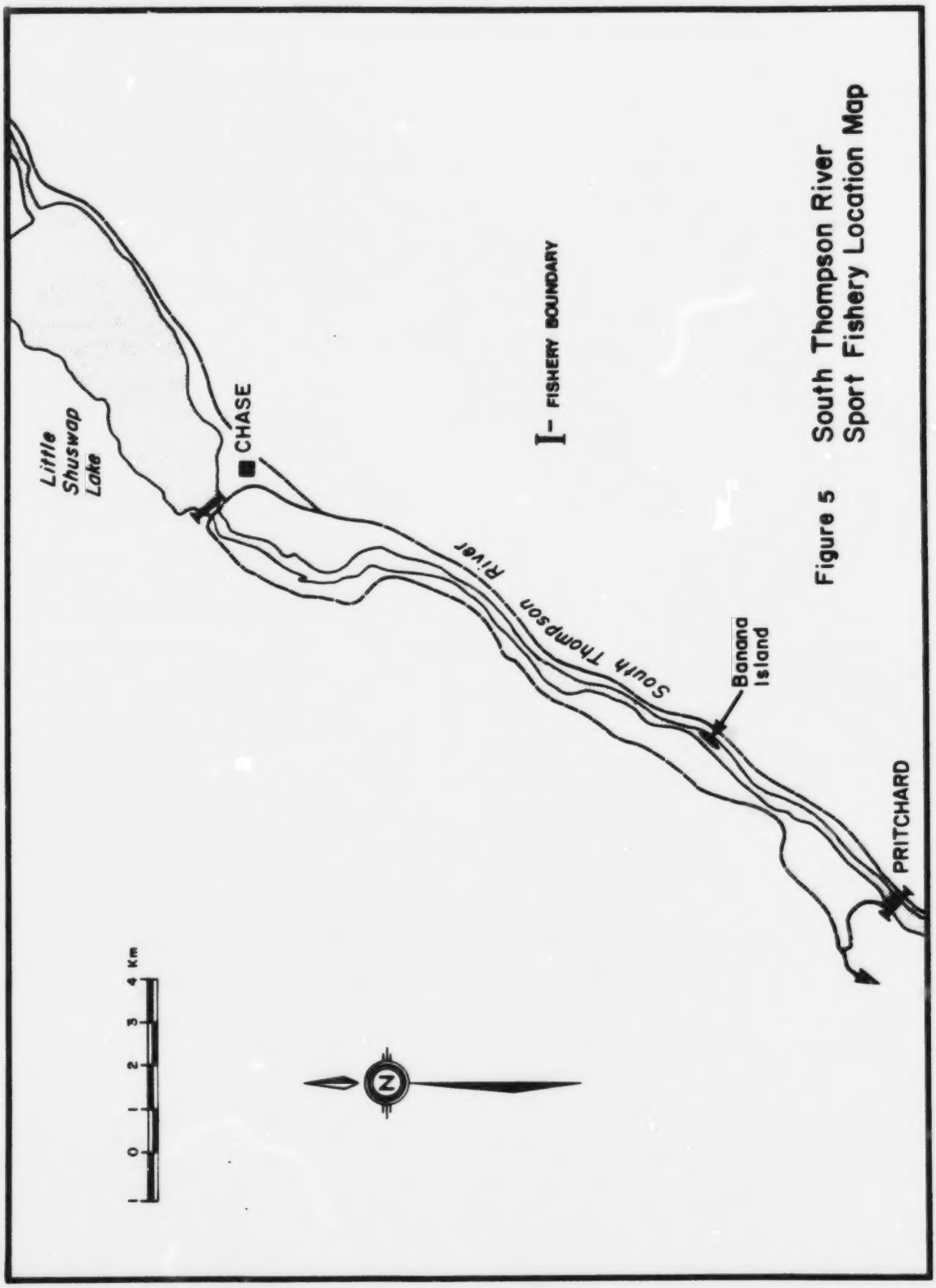


Figure 5 South Thompson River Sport Fishery Location Map

effort. A roving surveyor assessed the remaining sites.

Upon arrival at the site access, the surveyors requested that anglers report for an interview at the end of their fishing trip. On the morning shift, the surveyors also inquired if any anglers had left prior to 6:00 AM. The surveyors then remained at the site access to conduct hourly angler counts and exit interviews (complete trip interviews). At the end of the evening shift, any anglers still fishing were interviewed (incomplete trip interviews). Each interview recorded angler trip length (to time of interview and expected additional time, if any), target species, number and species harvested or released, identifying marks on harvested fish (fin or maxillary clip) and gear type. When possible, harvest was inspected to confirm species and mark identification. An interview form was completed for each angler; however, if the angler was unresponsive or if response reliability was questionable, the form was voided.

The roving surveyor travelled a predetermined route by vehicle, with a randomly selected start point and direction of travel. The surveyor's rate of travel through the fishery was standardized to ensure that a complete circuit encompassed seven hours. Anglers were approached on foot and interviewed as above. In addition to interviews, the surveyers counted all rods in the study area during the one hour period of expected peak daily angler effort (1:00 PM to 1:59 PM) (instantaneous rod count). No interviews were conducted during the rod count.

Bridge River

The Bridge River sport fishery was assessed by complete census between May 12 and July 31, 1987. One surveyor worked a 12 hour shift (8:00 AM to 8:00 PM) encompassing the entire daily open period. The open area was accessed by a single trail which enabled the surveyor to census the entire fishery. Daily procedures were identical to those described for the Bowron River, except instantaneous rod counts were not required and the chinook harvest was sampled for size (nose-fork length and weight), flesh color, sex, presence of an adipose fin and scales.

Quesnel River

The lower Quesnel River sport fishery was assessed, using a roving design, between July 14 and August 15, 1987. A single surveyor, working one of two eight hour shifts (6:00 AM to 2:00 PM; 1:00 PM to 9:00 PM), surveyed all open days. Procedures were similar to those described for the Bowron River, except instantaneous rod counts were conducted at randomly selected times during the period of expected maximum angler effort (10:00 AM to 3:00 PM).

Shuswap River

The Shuswap River sport fishery was assessed, using a hybrid design, between September 1 and September 22, 1987. Two surveyors, working one of two eight hour shifts (5:00 AM to 1:00 PM; 1:00 PM to 9:00 PM), surveyed all open days. One surveyor was stationed at Chuck's Pool, the area of maximum expected angler effort, while a roving surveyor assessed the remaining areas by vehicle. Daily procedures were similar to those described for the Bowron River, except instantaneous rod counts occurred during the two periods of expected daily effort maxima (6:00 AM to 7:30 AM on the morning shift; 7:00 PM to 8:30 PM on the afternoon shift).

South Thompson River

The South Thompson River sport fishery was assessed, using a hybrid

design, between September 10 and September 25. Two surveyors, working one of two eight hour shifts (6:00 AM to 2:00 PM; 12:00 PM to 8:00 PM), surveyed all open days. One surveyor was stationed at Banana Island, the area of maximum expected angler effort, while a roving surveyor assessed the remaining areas by boat. Daily procedures were similar to those described for Bowron River, except instantaneous rod counts occurred during the periods of expected daily effort maxima (7:00 AM to 7:59 AM on the morning shift; 6:00 PM to 6:59 PM on the afternoon shift).

DATA MANAGEMENT

Data storage and analysis were conducted on an IBM-AT compatible micro-computer. A custom designed data entry program (DPA Group Inc. MS 1985) was used to generate ASCII files. The hybrid survey files were then imported into a custom designed analysis program (DPA Group Inc. MS 1986), while the roving survey files were imported into a spreadsheet program for analysis.

The data were verified in three steps. First, all field data sheets were examined to ensure compliance with study procedures. Second, the data entry program performed 31 automatic error checks, including duplication detection, code validity, and range and consistency verification. Third, the ASCII data files were imported to a spreadsheet program for final verification with the field data sheets.

DATA ANALYSES

Bowron River

Angler Effort: Profiles of daily angler effort were generated from hourly rod counts at Beaver Bridge and Haggen Creek, with effort before 6:00 AM and after 9:00 PM reconstructed from interview data. Hourly effort was weighted to compensate for the sampling imbalance which resulted from overlapping survey shifts.

Mean sample-day angler effort (hours) was calculated for each stratum by dividing the mean rod count (from access point and roving surveys) by the proportion of daily effort occurring during the rod count time block (1:00 PM to 1:59 PM). Total angler effort was the product of the mean daily angler effort and the number of days in the stratum. The mathematical relationships are reported below. Variance calculations are detailed in Appendix 19.

1) Estimated total rods fishing ($\hat{R}_{hj}$), by hour and day type (weekday or weekend/ holiday):

$$\hat{R}_{hj} = \sum_{i} N_h / n_{hij} \sum_{k} r_{hijk}$$

2) Estimated proportion of daily angler effort occurring during the instantaneous rod count time block ($\bar{p}_{hj}^*$), by day type:

$$\bar{p}_{hj}^* = \frac{\hat{R}_{hj}^*}{\sum_{j} \hat{R}_{hj}}$$

3) Estimated mean rod count during the instantaneous rod count time block ($\bar{y}_{hj}^*$), by day type:

$$\bar{y}_{hj}^* = \sum_{k} \frac{y_{hj}^* k}{n_{hj}^*}$$

4) Estimated angler effort (E_h), by day type, in hours:

$$E_h = N_h \frac{\bar{y}_{hj}^*}{\bar{p}_{hj}^*}$$

5) Estimated study period angler effort (E), in hours:

$$E = \sum_h E_h$$

where:

N_h = total days of day type h (weekday or weekend/holiday) in the study period,

n_{hij} = number of interview sample days on day type h at site i during hour j,

r_{hijk} = rod count on day type h at site i at hour j on day k,

$\hat{R}_{hj^*}$ = estimated total effort (hours) on day type h during the instantaneous rod count time block (j*),

y_{hj^*k} = instantaneous rod count on day type h at all sites (access point and roving surveys) on day k,

n_{hj^*} = number of instantaneous rod counts on day type h at hour j*.

Catch Per Unit Effort: CPUE was calculated by species and mark group using a total ratio estimator (Von Geldern, Jr. and Thomlinson 1973; Malvestuto 1983), i.e. for the surveyed sites (Beaver Bridge, Haggen Creek and roving), the total estimated catch was divided by the total estimated effort (to time of interview). Estimates were derived from interview data weighted by the proportion of study period stints which were surveyed (for the purpose of analyses, the day was divided into three stints: 6:00 AM to 1:00 PM; 1:00 PM to 2:00 PM; and 2:00 PM to 9:00 PM) to account for sampling imbalances resulting from overlapping survey shifts and, for access point sites, by the proportion of anglers in each hour who left the site without an interview. CPUE was calculated separately for harvested (HPUE) and released (RPUE) fish; however, separate RPUEs were not calculated for unmarked and marked fish because angler mark recognition was considered unreliable. The mathematical relationships are reported below.

6) Estimated study period catch to time of interview at the survey sites ($\hat{X}_h$), by day type:

$$\hat{X}_h = \sum_i \sum_l \frac{1}{a_{hil}} \sum_f \sum_q \sum_u \frac{x_{hilfqu}}{a_{hilfqu}}$$

7) Estimated study period angler hours to time of interview at the survey sites ($\hat{T}_h$), by day type:

$$\hat{T}_h = \sum_i \sum_l \frac{1}{a_{hil}} \sum_f \sum_q \sum_u \frac{t_{hilfqu}}{a_{hilfqu}}$$

8) Estimated catch per angler hour at the survey sites ($\bar{c}_h$), by day type:

$$\bar{c}_h = \frac{\hat{X}_h}{\hat{T}_h}$$

where:

a_{hil} = proportion of total study period stints of type l for site i on day type h which were surveyed,

a_{hilfq} = proportion of anglers leaving in time block q on stint f of stint type l at site i on day type h who were interviewed,

x_{hilfqu} = catch to time of interview by angler u leaving in time block q on stint f of stint type l at site i on day type h,

t_{hilfqu} = hours fished to time of interview by angler u leaving in time block q on stint f of stint type l at site i on day type h.

Before calculating CPUE, the raw interview data were tested for significant differences in CPUE between complete and incomplete trip interviews and between sites. The test used, from Cochran (1977), was:

9) Estimated variance of the difference between two ratios ($Var(\bar{c}_c - \bar{c}_i)$):

$$Var(\bar{c}_c - \bar{c}_i) = Var(\bar{c}_c) + Var(\bar{c}_i)$$

where:

$Var(\bar{c}_c)$ = variance of CPUEs from complete trip interviews:

$$\frac{1}{n(n-1)\bar{t}^2}\left[\sum x_u^2 - 2\bar{c}_c \sum x_u t_u + \bar{c}_u^2 \sum t_u^2\right]$$

$Var(\bar{c}_i)$ = variance of CPUEs from incomplete trip interviews, calculated as above.

$\bar{t}$ = mean time to interview.

If $(\bar{c}_c - \bar{c}_i) \pm (t\text{-table}, 0.95)(Var(\bar{c}_c - \bar{c}_i))$ did not include zero, the difference was significant. If a significant difference in CPUEs was noted between complete and incomplete trip interviews, incomplete trip interviews were excluded from analysis for that site. If a significant difference in CPUEs was noted between sites, then equations 6, 7 and 8 were replaced with the following:

10) Estimated total catch to time of interview ($\hat{x}_{hi}$), by site and day type:

$$\hat{x}_{hi} = \sum_l \frac{1}{a_{hil}} \sum_f \sum_q \sum_u \frac{x_{hilfqu}}{a_{hilfq}}$$

11) Estimated total angler hours to time of interview ($\hat{t}_{hi}$), by site and day type:

$$\hat{t}_{hi} = \sum_l \frac{1}{a_{hil}} \sum_f \sum_q \sum_u \frac{t_{hilfqu}}{a_{hilfq}}$$

12) Estimated catch per angler hour ($\bar{c}_{hi}$), by site and day type:

$$\bar{c}_{hi} = \frac{\hat{x}_{hi}}{\hat{t}_{hi}}$$

13) Estimated mean catch per angler hour at all sites (weighted by site angler effort) ($\bar{c}_h$), by day type:

$$\bar{c}_h = \frac{\sum_i \bar{c}_{hi} E_{hi}}{\sum_i E_{hi}}$$

where:

$$E_{hi} = N \frac{\bar{y}_{hij}^*}{\bar{p}_{hj}^*}$$

= estimated total angler effort at site i on day type h,

$\bar{y}_{hij}^*$ = mean rod count at site i on day type h during the instantaneous rod count time block.

Harvest and Release: Total harvest and release, estimated by species and mark group, was the sum of individual estimates for the weekday and weekend/holiday strata. For each stratum, harvest and release was the product of stratum effort and the corresponding value of HPUE or RPUE.

14) Total study period catch (C):

$$C = \sum_h \bar{c}_h E_h$$

Harvest Rate: In all study areas, the harvest rate of chinook adults was calculated by dividing the estimated harvest by the sum of the estimated harvest and the observed escapement (provided by field staff). Harvest rates were not calculated for other species because total abundance was unknown.

Angler Characteristics: In all study areas, the following unweighted angler attributes were summarized by site and day: mean angler day length by weather type (clear, overcast and rain), mean angler day length from complete and incomplete trip interviews, numbers of anglers targeting on each species and preferred gear type.

To estimate mean angler day length, the roving survey data were first corrected for length of stay bias, described by Lucas (1963), as follows:

15) $$\bar{d} = \frac{\sum_d n_d}{\sum_d n_d/d}$$

where:

$\bar{d}$ = mean angler day length (hours),

d = angler day length (in one hour increments),

n_d = number of incomplete trip interviews of day length d.

Estimates of angler day length from complete and incomplete surveys, weighted by number of interviews, were combined to estimate mean angler day length for the roving survey areas. For hybrid surveys, study period angler day length was estimated by combing access point and roving survey estimates weighted by angler effort.

Bridge River

Because the Bridge River study was a complete census, angler effort, CPUE and catch were measured directly: angler effort was the sum of the observed hours fished by all anglers; catch was the sum of the observed catch to time of interview; and CPUE was the ratio of catch and angler effort. The mathematical relationships are reported below.

16) Total angler effort (E) in hours:

$$\sum_{j=900}^{2000} \frac{\sum_k r_{kj} + \sum_{.k} r_{kj-1}}{2}$$

17) Total study period catch (C);

$$C = \sum_u x_u$$

18) Total catch per angler hour (c):

$$\bar{c} = C/E$$

Quesnel River

Angler Effort: Profiles of hourly angler effort were generated from angler interview data, with hourly effort weighted to compensate for sampling imbalances resulting from overlapping survey shifts and random effort counts.

Total sample day angler effort (hours) was calculated for each stratum (weekday or weekend/holiday) by dividing the rod count by the proportion of the daily effort occurring in that time block. Rod counts were conducted during the period of maximum expected effort, but scheduled to ensure that at least two interview shifts occurred in each hourly time block. Mean daily angler effort (and its variance) was calculated for each stratum. Stratum totals were the product of the mean daily angler effort and the number of days in each stratum. Total angler effort and associated variance was produced by combining stratum totals and variances. The mathematical relationships, based on Mendenhall **et al.** (1971), were:

19) Estimated stratum mean daily effort ($\bar{e}_h$), in hours:

$$\bar{e}_h = (\sum_k y_j{}^*{}_k/p_j{}^*)/n_j{}^*$$

20) Total study period angler effort (E) and variance (Var(E)), all in hours:

$$E = \sum_h \bar{e}_h N_h$$

$$Var(E) = \sum_h \left[N_h^2 \left(s_h^2 / n_h \right) \left(fpc_h \right) \right]$$

where:

$y_j{}^*{}_k$ = instantaneous rod count at all sites on day k,
$\bar{p}_j{}^*$ = proportion of daily angler effort (hours) during the instantaneous rod count time block (as determined from interview data),
$n_j{}^*$ = number of instantaneous rod counts at hour j*,
N_h = number of days in stratum h,
s_h = sample variance in stratum h,
fpc_h = finite population correction for stratum h.

Catch Per Unit Effort: CPUE was calculated by species and mark group for each stratum using a total ratio estimator. In general, CPUE was estimated as described for the Bowron River, except observed catch and effort to time of interview were used, and the data were not weighted by the proportion of anglers leaving without being interviewed. CPUEs and their variances were calculated as follows:

21) Catch per unit effort ($\bar{c}$):

$$\bar{c} = \sum_1 \frac{w_1 \left(\sum_u x_u / \sum_u t_u \right)}{\sum_1 w_1}$$

22) Variance of CPUE ($Var(\bar{c})$)

$$Var(\bar{c}) = (1/\bar{t}^2) \sqrt{\frac{\sum_u ((x_u - \bar{c}) t_u)^2}{n(n-1)}}$$

where:

x_u = catch to time of interview of angler u,
t_u = hours fished to time of interview by angler u,
$\bar{t}$ = mean time spent angling to time of interview,

n = number of anglers interviewed in stratum,
w_1 = proportion of stints of type 1 which were surveyed.

Harvest and Release: Total harvest and release, by species and mark group, was calculated as in Equation 14. Variance was calculated as follows:

23) $Var(C) = E\ Var(\bar{c}) + \bar{c}\ Var(E) + Var(E)Var(\bar{c})$

Shuswap River

Lower Shuswap River data were analysed using the procedure described for the Bowron River study, except only a single day type stratum was used. Angler effort was calculated from the profile observed at Chuck's Pool and from instantaneous counts from the roving and Chuck's Pool surveys. CPUE was generated from information collected at Chuck's Pool and by the roving survey.

South Thompson River

South Thompson River data were analysed using the procedures described for the Bowron River study, except a single day type stratum was used. Angler effort was calculated from the profile observed at Banana Island and from instantaneous counts from the roving and Banana Island surveys. CPUE was generated from information collected at Banana Island and by the roving survey.

RESULTS

Study results for the five upper Fraser River chinook sport fisheries

Table 2. Summary of 1987 harvest and angler effort, by fishery (95% confidence limits in parentheses).

	Bowron River	Bridge River	Quesnel River	Shuswap River	South Thompson River	All areas
Number of interviews	407	887	74	364	269	2,001
Angler effort (hr)	4,769	2,671	1,211	6,071	5,671	20,393
Angler effort (day)	1,039	840	205	1,248	1,177	4,509
Harvest						
Chinook adult	121 (63)	115 -	16 (43)	215 (376)[a]	36 (46)	503
Chinook jack	3 (4)	3 -	0 -	8 (20)	0 -	14
Rainbow	116 (60)	0 -	0 -	10 (26)	0 -	126
Dolly Varden	237 (218)	0 -	0 -	0 -	0 -	237
Whitefish	38 (34)	0 -	0 -	0 -	0 -	38
Release						
Chinook adult	0 -	0 -	0 -	8 (18)	0 -	8
Rainbow	76 (82)	0 -	0 -	10 (28)	0 -	86
Steelhead	0 -	3 -	0 -	0 -	0 -	3
Dolly Varden	26 (22)	0 -	0 -	0 -	0 -	26
Whitefish	38 (47)	0 -	0 -	0 -	0 -	38
Squawfish	0 -	0 -	0 -	10 (26)	0 -	10

[a] Includes 31 with adipose fin clips.

Table 3. Summary of 1987 angler characteristics, by fishery.[a]

	Bowron River	Bridge River	Quesnel River	Shuswap River	South Thompson River
Mean angler day length (hr)	4.59	3.18	5.90	4.86	4.82
Target species (%)					
Chinook	73.7	100.0	87.8	93.7	75.2
Trout [b]	4.7	0.0	12.2	3.6	0.0
Anything	21.6	0.0	0.0	2.7	24.8
Gear (%)					
Bait	0.5	87.9	12.2	34.9	19.0
Lure	83.8	4.1	56.8	34.9	78.8
Bait/Lure	15.7	8.0	25.7	29.1	1.9
Fly	0.0	0.0	5.4	1.1	0.4

[a] Data are unweighted, except angler day length adjusted for length of stay bias.

[b] Includes rainbow, whitefish or Dolly Varden.

are summarized in Tables 2, 3 and 4. Based on 2,001 interviews, an estimated 20,393 angler hours (4,509 angler days) were expended to harvest (release) 503 (8) chinook adults, 14 chinook jacks, 126 (86) rainbow trout (**Oncorhynchus mykiss**), 0 (3) steelhead trout (**O. mykiss**), 237 (26) Dolly Varden char (**Salvelinus malma**), 38 (38) whitefish (**Prosopium sp.**) and 0 (10) squawfish (**Ptychocheilus oregonensis**). Chinook adult harvest rates ranged from 0.2% to 2.1%.

All fisheries were successful in attracting anglers primarily interested in harvesting chinook salmon. The average angler fished for 3.2 to 5.9 hours per day using bait, lures or a combination of the two; few fished with flies. The average angler expended 28 to 81 hours to harvest one chinook adult. Results by study area are detailed below.

BOWRON RIVER

Effort Distribution

Four hundred and seven anglers were interviewed on 12 survey days during the 16 day study period (Appendix 1). Of that total, 142 were interviewed at Beaver Bridge, 104 at Haggen Creek and 161 in the remaining areas. Instantaneous rod counts were conducted each survey day (Appendix 2); however, the area between the Bowron and Beaver Forest Road bridges was not surveyed due to limited angler effort the previous year. Effort in part of Region 6 was estimated from vehicle counts due to the chronic presence of uncooperative anglers. Angling occurred primarily at road access points. Although access by boat or over extended distances on foot was limited, it increased from 1986.

Angler Effort

Daily Profile: Anglers fished from 0400 h to 2200 h, with 80% of the effort occurring from 1100 h to 2100 h (Appendix 3; Fig. 6). Weekday effort peaked at 2000 h, while weekend effort started earlier and peaked at 1400 h.

Total Angler Effort: Study period angler effort totaled 4,769 angler hours or 1,039 angler days (Table 2), of which 60% occurred on weekend or holiday days. Twenty-two percent of the effort occurred at Beaver Bridge and 23% at Haggen Creek, with most of the remainder in regions 5 and 6.

Catch Per Unit Effort

Harvest: Because a significant difference ($p < 0.05$) was noted between chinook adult HPUEs estimated from complete and incomplete trip interviews, 225 incomplete trip interviews were excluded from CPUE analysis. Weighted chinook adult HPUE, expressed as fish per hour, was estimated at 0.0210. HPUE from the roving survey was significantly higher than at Beaver Bridge and Haggen Creek. HPUE also tended to be higher on weekend and holiday days (Appendix 4a). The maximum daily HPUE of 1.000 was recorded at Haggen Creek on July 27.

Release: Chinook were not released during the study. RPUEs for other species are reported in Appendix 4.

Harvest

Harvest was estimated at 121 chinook adults, 3 chinook jacks, 116 rainbow trout, 237 Dolly Varden char and 38 whitefish (Table 2). None of the harvested chinook were missing an adipose fin. Enforcement staff reported disproportionate chinook adult harvest in the unevaluated portion of Region 6. Harvest, therefore, may have been underestimated.

Release

An estimated 76 rainbow trout, 26 Dolly Varden char, 38 whitefish and 1,086 unidentified fish were intentionally released in 1987 (Table 2).

Angler Characteristics

Angler day Length: Anglers fished an average 4.59 hours per trip (Table 3). Angler day length was shorter for complete trip relative to incomplete trip interviews, averaging 4.05 hours and 6.15 hours, respectively (Appendix 1). Anglers fished an average 3.96, 5.90 and 3.64 hours on clear, overcast and rainy days, respectively.

Target Species: Anglers attempted to harvest chinook (74%), Dolly Varden or rainbow (5%) or anything (22%) (Table 3).

Gear Type: Lures were the most commonly used gear (84%), followed by bait/lure combinations (16%). Less than 1% of the anglers used bait or flies (Table 3).

BRIDGE RIVER

Effort Distribution

Eight hundred and eighty-seven anglers were interviewed during the 15 day study period (Appendix 5). Angling was censused at a single site near the Bridge River mouth.

Angler Effort

Daily Profile: Regulations restricted angling to 0800 h to 2000 h. Daily effort was bimodal, with peaks at 1000 h and 1800 h (Appendix 3; Fig. 6).

The daily profile was measured in two ways. First, the true profile was known from hourly observations of all anglers. Second, a profile was estimated from interview estimates of time fished. The profiles were similar in general shape and, although the interview profile was shifted to the left (Fig. 6), the difference was not significant ($p > 0.05$; Kolmogorov-Smirnov two sample test).

Total Angler Effort: Study period angler effort totaled 2,671 hours, or 840 angler days (Table 2).

Catch Per Unit Effort

Harvest: HPUE was 0.0431 and 0.0011 for chinook adults and jacks, respectively (Appendix 7). Chinook adult HPUE showed three general pulses, with the maximum daily HPUE of 0.120 recorded on June 2.

Release: Steelhead trout RPUE was 0.0011 (Appendix 7).

Harvest

Harvest totaled 115 chinook adults and 3 chinook jacks (Table 2).

Harvest Sampling: Sample results from the 1987 Bridge River sport fishery harvest are detailed in Appendix 8. The harvest consisted primarily of males (58.5%) and red fleshed (94.1%) chinook salmon. Overall size averaged 80.1 cm nose-fork length and 6.9 kg round weight. The harvest consisted of ages 5_2 (52.1%), 4_2 (41.1%), 3_2 (4.1%) and 3_1 (2.7%), with the females predominately aged 5_2 (96.4%) and the males 4_2 (64.4%).

Release

Release totaled 3 steelhead trout (Table 2).

Angler Characteristics

Angler Day Length: Anglers fished an average 3.18 hours per trip (Table 3). Anglers fished an average

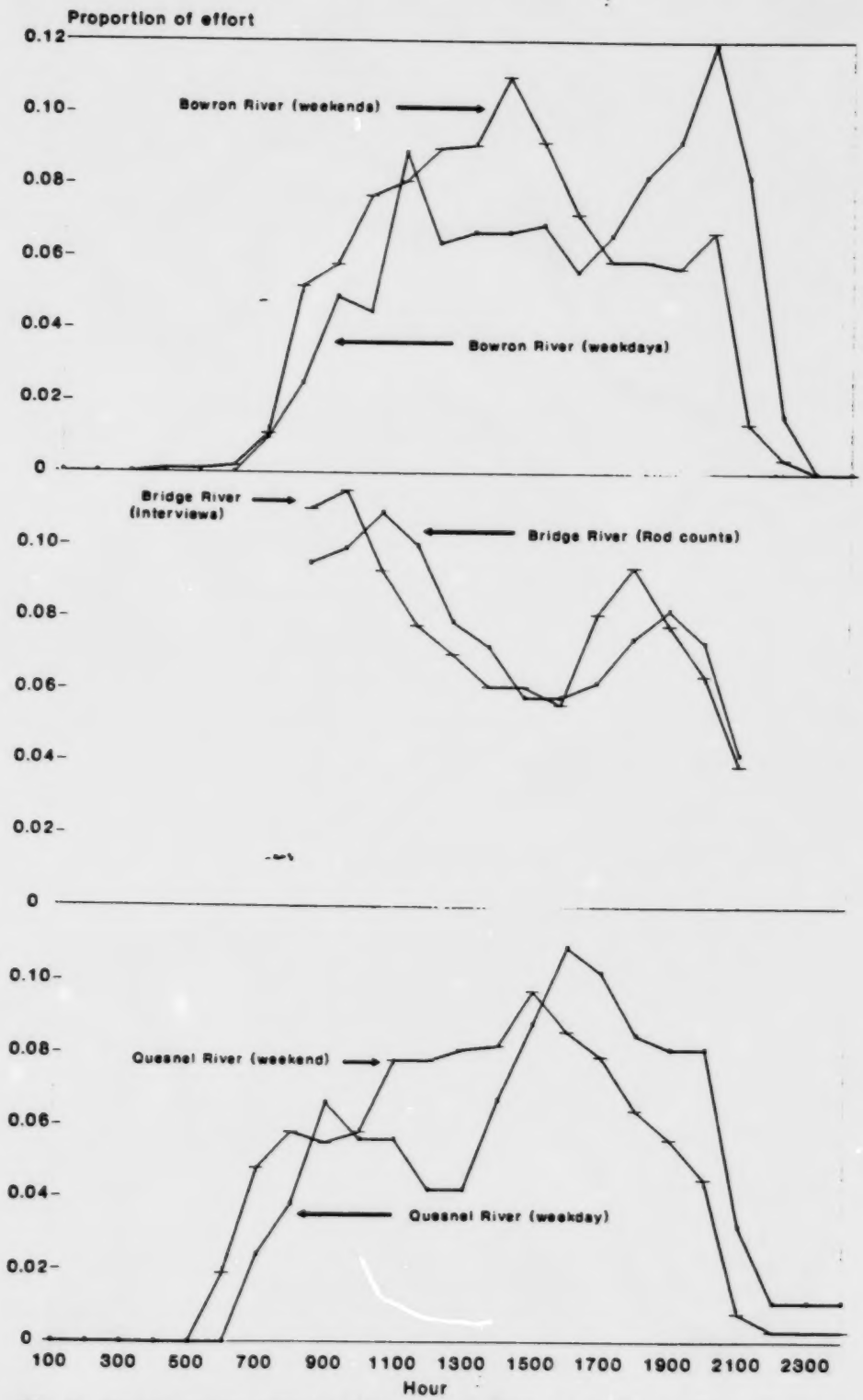


Fig. 6. Hourly angler effort profiles in the 1987 upper Fraser River sport fisheries.

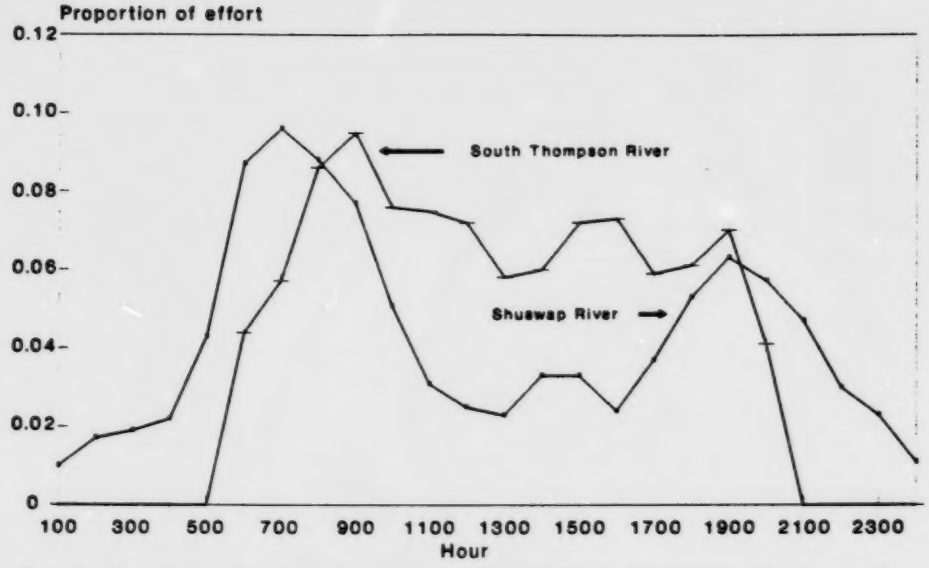


Fig. 6. Hourly angler effort profiles in the 1987 upper Fraser River sport fisheries continued.

3.16, 3.26 and 2.88 hours on clear, overcast and rainy days, respectively.

Target Species: All anglers were attempting to harvest chinook salmon (Table 3).

Gear Type: Bait was the most commonly used gear (88%), followed by bait/lure combinations (8%) and lures (4%). Flies were not used in the Bridge River fishery.

Angler Success: Because study data were from a complete census they provide a relatively unbiased assessment of the relationship between angler success and trip length (Appendix 18b, Fig. 7). Successful anglers tended to harvest a chinook adult soon after they began angling, with the probability of success declining sharply with time. For example, anglers who had fished for two hours or less constituted 38% of the anglers and 16% of the total angler effort, but harvested 63% of the chinook adults. HPUE for these anglers was 0.1601, compared to the mean HPUE of 0.0431.

QUESNEL RIVER

Effort Distribution

Seventy-four anglers were interviewed during the ten day study period (Appendix 9). Instantaneous rod counts were conducted each open day (Appendix 10). Anglers accessed the river primarily by road, although some anglers used boats in regions 4, 5 and 6. Effort was greatest near the mouth of Beaver Creek (41%), while a further 42% of the anglers accessed the river from the north in regions 2 and 3. No anglers were observed near the mouth during the instantaneous rod counts.

Angler Effort

Daily Profile: Anglers fished from 0600 h to 2400 h, with 80% of the effort occurring from 1000 h to 2000 h (Appendix 3; Fig. 6). Weekday effort started and peaked later than weekend effort.

Total Angler Effort: Study period angler effort totaled 1,211 hours or 205 angler days (Table 2), of which 65% occurred on weekend/holiday days. Angler effort on the average weekday (105 hours) was approximately 66% of that on the average weekend/ holiday day (158 hours).

Catch Per Unit Effort

Harvest: Because a significant difference ($p < 0.05$) was noted in chinook adult HPUEs estimated from complete and incomplete trip interviews, 60 incomplete trip interviews were eliminated from the CPUE analysis. Weighted chinook adult HPUE was estimated at 0.0204 (Appendix 11a). HPUE was higher on weekend days, the only day type where chinook harvest was recorded.

Release: Chinook adult RPUE was estimated at 0.000; however, incomplete trip interviews recorded the release of one chinook adult (Appendix 11b).

Harvest

Harvest was estimated at 16 chinook adults (Table 2). Because complete trip interviews did not report harvest for other species, no other estimates were made. If incomplete trip interviews were included in the analysis, however, the estimated harvest would include rainbow trout and whitefish.

Release

Based on complete trip interviews, no fish of any species were released. If incomplete trip interviews were included in the analysis, estimated release would include chinook adults.

Angler Characteristics

Angler Day Length: Anglers fished an average 5.90 hours per trip (Table 3). Angler day length was shorter for complete trip relative to incomplete trip interviews, averaging 5.43 and 7.92 hours, respectively (Appendix 9). Anglers fished an average 8.16, 7.57 and 6.82 hours on clear, overcast and rainy days, respectively.

Target Species: Anglers attempted to harvest chinook (88%), rainbow (including rainbow in conjunction with Dolly Varden) (11%) or Dolly Varden (1%) (Table 3).

Gear Type: Lures were the most commonly used gear (57%), followed by bait/lure combinations (26%), bait (12%) and flies (5%) (Table 3).

SHUSWAP RIVER

Effort Distribution

Three hundred and sixty-four anglers were interviewed during the seven day study period (Appendix 12), 220 at Chuck's Pool and 144 in the remaining areas. Instantaneous rod counts were conducted each open day (Appendix 13), with angling occurring near road access points throughout the lower Shuswap River. Thirty-one percent of the anglers were observed between Mable Lake and Skookumchuck, with a further 24% between Fall and Cooke creeks and 22% between Mara Lake and Ashton Creek Bridge. Few anglers were observed between Cooke Creek and Skookumchuck.

Angler Effort

Daily Profile: Anglers fished from 0001 h to 2400 h (Appendix 3;

Fig. 6). Effort was bimodal, with peaks at 0700 h and 1900 h.

Total Angler Effort: Study period angler effort totaled 6,071 angler hours, or 1,248 angler days (Table 2). Twenty-nine percent of the effort occurred at Chuck's Pool, with the remainder distributed through the other areas.

Catch Per Unit Effort

Harvest: Because a significant difference ($p < 0.05$) was noted between chinook adult HPUEs estimated from complete and incomplete trip interviews, 208 incomplete trip interviews were excluded from CPUE analysis. Weighted HPUE was estimated at 0.0355 and 0.0013 for chinook adults and jacks, respectively (Appendix 14). Chinook adult HPUEs of 0.0281 and 0.0569 were estimated for Chuck's Pool and the roving sites, respectively; however, the difference was not significant ($p > 0.05$).

Release: Chinook adult RPUE was estimated at 0.0013. RPUE for other species is reported in Appendix 14.

Harvest

Harvest was estimated at 215 chinook adults (including 31 with adipose fin clips), 8 chinook jacks and adipose fin clips), 8 chinook jacks and 10 rainbow trout (Table 2). If incomplete trip interviews were included in the analysis, the harvest estimate would include squawfish.

Release

Release was estimated at 8 chinook adults, 10 rainbow trout and 10 squawfish (Table 2). If incomplete trip interviews were included in the analysis, the release estimate would include whitefish.

Angler Characteristics

Angler Day Length: Anglers fished an average 4.86 hours per trip (Table 3). The average angler day was shorter for complete trip relative to incomplete trip interviews, averaging 4.38 and 6.91 hours, respectively. Anglers fished an average 5.94 and 4.71 hours on clear and overcast days, respectively.

Target Species: Anglers attempted to harvest chinook (94%), trout (4%) or anything (3%) (Table 3).

Gear Type: Bait (35%) and lures (35%) were the most commonly used gear, followed by bait/lure combinations (29%) and flies (1%) (Table 3).

SOUTH THOMPSON RIVER

Effort Distribution

Two hundred and sixty-nine anglers were interviewed during the five day study period (Appendix 15), 81 at Banana Island and 188 in the remaining areas. Instantaneous rod counts were conducted each day (Appendix 16). Anglers accessed the fishery by both road and boat. Effort was greatest in Region 3, a 5 km section which included Banana Island, with smaller concentrations near Chase and Pritchard.

Angler Effort

Daily Profile: Anglers fished from 0600 h to 2000 h, with 85% of the effort occurring between 0800 h and 1900 h (Appendix 3: Fig. 6). Angler effort peaked at 0900 h but tended to be relatively consistent through most of the day.

Total Angler Effort: Study period angler effort totaled 5,671 hours, or approximately 1,177 angler days (Table 2). Thirty-two percent of the effort occurred at Banana Island, with the remainder distributed through regions 1, 3 and 4.

Catch Per Unit Effort

Harvest: Because a significant difference ($p < 0.05$) was noted between chinook adult HPUEs estimated from complete and incomplete trip interviews, 179 incomplete trip interviews were excluded from CPUE analysis. A further 27 complete trip interviews from the roving survey were excluded because the surveyor did not comply with survey procedures. Weighted chinook adult HPUE (from complete trip interviews collected at Banana Island) was estimated at 0.0055 (Appendix 17). HPUE was high early in the study period, with the maximum daily chinook adult HPUE of 0.033 recorded on September 11.

Release: Chinook adult RPUE was estimated at 0.000; however, roving survey incomplete trip interviews recorded the release of chinook adults, chinook jacks and whitefish (Appendix 17).

Harvest

Harvest was estimated at 36 chinook adults (Table 2). Because complete trip interviews did not report harvest of other species, no other estimates were made; however, if incomplete trip interviews were included in the analysis, estimated harvest of other species would include rainbow trout and squawfish.

Release

Based on complete trip interviews, no fish of any species were released. If incomplete trip interviews were included in the analysis, estimated release would include chinook adults, chinook jacks and whitefish.

Angler Characteristics

Angler Day Length: Anglers fished an average 4.82 hours per trip (Table 3). Angler day length was shorter for complete trip relative to incomplete trip interviews, averaging 3.87 and 6.64 hours, respectively (Appendix 15). Weather was clear on all open days.

Target Species: Anglers attempted to harvest chinook (75%) or anything (25%) (Table 3).

Gear Type: Lures were the most commonly used gear (79%), followed by bait (19%), bait/lure combinations (2%) and flies (0.4%) (Table 3).

DISCUSSION

GENERAL

Bowron River

The effectiveness of the 1987 Bowron River chinook sport fishery increased dramatically over 1986 (Table 4). Although chinook abundance declined by 35%, angler effort, harvest, harvest rate and HPUE all increased substantially over 1986. Improved fishery performance can be partially attributed to changes in escapement estimation techniques. Escapement was based on a fence count in 1986 and visual surveys in 1987. Because visual surveys generally underestimate escapement (Cousens **et al.** 1982), harvest rate and catchability may have been overestimated in 1987; however, this does not explain the increase in HPUE observed in 1987. For example, the effort required to harvest one chinook salmon declined from 245 hours in 1986 to 39 hours in 1987. Three factors may be involved. First, much of the improved performance may be attributed to the substantial increase in the number of accessible angling sites which resulted from a doubling of the open area. For example, HPUEs at Haggen Creek and the roving sites were both higher than at Beaver Bridge, the only assessed site in the the 1986 open area. Second, because 1987 was the second year the Bowron River was open to chinook angling,

Table 4. Summary of 1987 harvest rate, catchability and harvest per unit effort (HPUE), by fishery.

Fishery	Year	Angler effort (h_r)	Chinook adult Harvest	Escapement	Catchability coefficient ($\times 10^{-6}$)	Harvest rate %	Mean HPUE
Bowron River	1987	4,769	121	6,000	4.15	1.98	0.0210
	1986	3,179	13	9,465	0.43	0.14	0.0041
Bridge River	1987	2,671	115	65,344 [a]	0.66	0.18	0.0431
Quesnel River	1987	1,211	16	5,847	2.23	0.27	0.0204
Shuswap River	1987	6,071	215	10,000	3.48	2.10	0.0355
	1986	6,145	237	12,000	3.15	1.94	0.0386
South Thompson R.	1987	5,671	36	8,500	0.74	0.42	0.0055

[a] Sum of escapement, Indian food fishery and sport fishery harvest upstream from Bridge River.

angler experience may have increased over 1986. Third, the inclusion of weekend and holiday days in the open period may have increased overall fishery performance. Weekend anglers accounted for 60% of the angler effort and were more successful than weekday anglers.

The 1987 Bowron River chinook sport fishery study may have underestimated angler effort and HPUE and, therefore, chinook adult harvest. Angler effort may have been underestimated because rod counts were not conducted between the river mouth and approximately 200 m below the Beaver Forest Road Bridge. In 1986, approximately 6% of the effort was recorded in that area. HPUE may have been underestimated because angler hostility precluded interviewing in a portion of Region 6. Enforcement staff reported snagging to be highly effective in this location, with HPUEs considerably higher than other areas. Despite these deficiencies, however, the 1987 regulations constrained harvest to a level well below the 300 chinook adult ceiling despite large expansions in both the open area and fishing time.

Bridge River

The 1986 sport fishery policy allowed upper Fraser River fisheries to reopen in terminal areas where escapements were improving faster than expected, the stocks were enhanced, and harvest could be restricted to single stocks. The 1987 mixed stock chinook sport fishery at Bridge River, a departure from that policy, was opened for three reasons. First, the upper and middle Fraser River chinook stocks vulnerable in the fishery were rebuilding at a rate faster than in other parts of the drainage. The 1986 aggregate escapement of these stocks was 50% above the rebuilding goal (Pacific Salmon Commission 1988), with only four of 21 escapement indicator stocks below their respective goals. Second, the fishery was constrained to a harvest ceiling which would minimize impacts on even the slowest rebuilding stock. For example, the ceiling represented an anticipated harvest rate of 0.5%; the actual harvest rate

was only 0.2%. Third, the fishery could be censused and effectively monitored for regulations violations due to limited access.

Both the chinook harvest rate and the catchability coefficient in the Bridge River sport fishery were the lowest observed in 1987 (Table 4); however, the fishery was a relatively effective harvester of chinook salmon. The mean HPUE of 0.0405 was the highest observed in any 1987 sport fishery, with only 24 angler hours required to harvest one chinook adult.

Quesnel River

The 1987 lower Quesnel River sport fishery attracted minimal angler effort and, among the surveyed fisheries, was the least effective harvester of chinook salmon (Table 4). The fishery accounted for only 6% of the 1987 overall angler effort, and 81 hours were required to harvest one chinook adult. On the basis of the 1987 study results, further intensive assessment will not be required until fishery performance improves.

Shuswap River

The lower Shuswap River supported the most intensive of the five upper Fraser River chinook sport fisheries, accounting for 30% (6,071 angler hours) of the overall angler effort (Table 4). Angler success, as measured by chinook harvest, harvest rate, HPUE and catchability coefficient, was among the highest observed in 1987. On average, 28 angler hours were required to harvest one chinook adult. Overall fishery performance in 1986 and 1987 were similar.

South Thompson River

The South Thompson River sport fishery was a relatively ineffective harvester of chinook salmon. Angler success was among the lowest noted in 1987 despite the large number of chinook adults vulnerable to a relatively intense angler effort (Table 4).

Estimation precision and accuracy were reduced by the exclusion of roving survey data from the analysis. Reduced precision resulted from the reduced sample size. Estimation accuracy was dependent on the assumption that data collected at Banana Island were representative of the entire fishery.

INCOMPLETE TRIP INTERVIEW BIAS

Significant differences ($p < 0.05$) in chinook adult HPUEs from complete and incomplete trip interviews (Table 5) resulted in the exclusion of the latter from the analysis. A negative bias in incomplete trip HPUEs, noted for both roving and access point surveys, probably resulted from the regulation restricting daily angler harvest to a maximum of one chinook salmon. It was likely that successful anglers left the fishery soon after harvesting a chinook salmon; therefore, the anglers contacted during their angling trip or those still present at a site at the end of a survey shift continued angling because they had yet to harvest a chinook salmon. Inclusion of such incomplete trip interview data would introduce a negative bias in the HPUE estimate.

The exclusion of incomplete trip interviews influenced the 1987 study results in four ways. First, estimation precision was reduced due to the exclusion of a large proportion (60.3%) of the interviews. Second, because roving surveys have a greater tendency to contact anglers during their trip, roving data were disproportionately excluded from analysis resulting in a reduction in the number of sites used to estimate HPUE.

Table 5. Estimated 1987 chinook adult harvest per unit effort (HPUE) from complete and incomplete trip interviews, by fishery.

		Complete trip interviews				Incomplete trip interviews			
Location	Site	No.	Angler hours	Chinook adult harvest	Chinook adult HPUE	No.	Angler hours	Chinook adult harvest	Chinook adult HPUE
Bowron River	Beaver Bridge	74	262.5	4	0.015	68	130.5	0	0.000
	Haggen Creek	60	290.5	5	0.017	44	296.5	5	0.017
	Roving	48	184.5	10	0.054	113	260.5	1	0.004
Quesnel River	Roving	14	76.0	1	0.013	60	202.5	0	0.000
Shuswap River	Chuck's Pool	141	621.5	23	0.037	79	297.5	0	0.000
	Roving	15	65.0	4	0.062	129	536.0	0	0.000
South Thompson River	Banana Island	63	240.5	2	0.008	18	62.0	0	0.000
	Roving	27	87.0	5	0.057	161	592.5	2	0.003

Although potential bias was treated by statistically comparing HPUE between sites, the limited available data from some roving surveys made the detection of differences difficult. Third, because the number of sites surveyed was reduced, harvest and release estimates did not adequately represent true species diversity. For example, the estimated number of species harvested and released was reduced by five and six, respectively, when incomplete trip interviews were eliminated. Fourth, while the exclusion of incomplete trip interviews was appropriate for the estimation of the catch of chinook salmon, the target species of most anglers (Table 3), it may not have been appropriate for the nontarget species. Although HPUE differences existed between complete and incomplete trip interviews for other species, the differences appeared random. This suggests that HPUE for these species may be relatively constant through the day and that incomplete trip interviews should be included in the analysis for these species. Thus, when large differences existed in estimates for these species, catch estimates from both complete and incomplete trip interviews were noted in the results.

In view of the impact on study results, the regulation restricting daily angler harvest to one chinook salmon should be relaxed in fisheries evaluated in part by roving surveys. Because recent HPUEs were low and harvest was well below fishery ceilings, no other regulatory changes would be necessary to compensate for increased harvest.

BIAS IN EFFORT PROFILE ESTIMATION

The census of the Bridge River sport fishery permitted an evaluation of bias in the use of angler interviews to construct daily effort profiles. In comparison with the true effort profile, known from hourly rod

counts, the profile constructed from angler interviews was similar in shape but shifted to the left. The difference was primarily an artifact of rounding angler trips to the nearest half hour, although some tendency for anglers to overestimate trip length was also noted. Although the difference in shape was not statistically significant, this finding has important implications for certain types of sport fishery surveys. For example, many access point/overflight study designs maximize precision by scheduling instantaneous rod counts to coincide with the period of maximum daily angler effort (DPA Group MS 1982). Because deviation from the true effort profile was greatest at the estimated time of peak angler effort, such study designs will maximize effort estimation error rather than precision.

To illustrate the sensitivity of such studies to effort profile estimation error, the Bridge River data were used to simulate an instantaneous rod-count at the time of maximum daily effort, as estimated from interviews (0900). Harvest was underestimated by approximately 10%. Although angler overestimation of trip duration was minor in this study, the direction of this bias would compound the impact of underestimation of angler effort.

Further study is required to make a definitive statement regarding this bias. The impact on the current study was minor because, with the exception of the lower Quesnel River, all effort profiles were estimated through direct observation. Although Quesnel River results may have been biased, the fishery was an ineffective harvester of chinook salmon, minimizing the overall impact. It is recommended, however, that future studies which estimate angler profiles from interviews record the actual time the angler's trip started rather than rounding to the nearest half hour.

RELATIONSHIP BETWEEN TRIP LENGTH AND HARVEST

An assumption underlying roving sport fishery assessment surveys is that catch per unit effort is independent of trip length (Malvestuto 1983). To examine this assumption, HPUEs from complete trip interviews were examined by trip length (Fig. 7; Appendix 18). The results show an inverse relationship between HPUE and trip length for the Bridge River, lower Shuswap River and South Thompson River fisheries, with only the Bowron River fishery meeting the assumption. This suggests that successful anglers harvested chinook salmon shortly after arrival, then left immediately. While much of this trend may be eliminated by increasing the daily angler bag limit, it suggests caution when designing roving surveys to evaluate these fisheries.

RECOMMENDATIONS

1. The 1987 sport fishery regulations were successful in constraining harvest to levels well below the fishery harvest ceilings. Contingent upon future stock strength, regulations could be relaxed in all of the study areas without exceeding fishery ceilings.

2. Because the regulation restricting angler harvest to one chinook per day introduced bias into the study results, this regulation should be changed to two chinook per day in future fisheries. In most cases, HPUEs were sufficiently low to eliminate angler contact bias without exceeding fishery harvest ceilings.

3. The Bridge River fishery census identified a potential bias in daily effort profiles derived from angler interviews. To minimize this bias, it is recommended

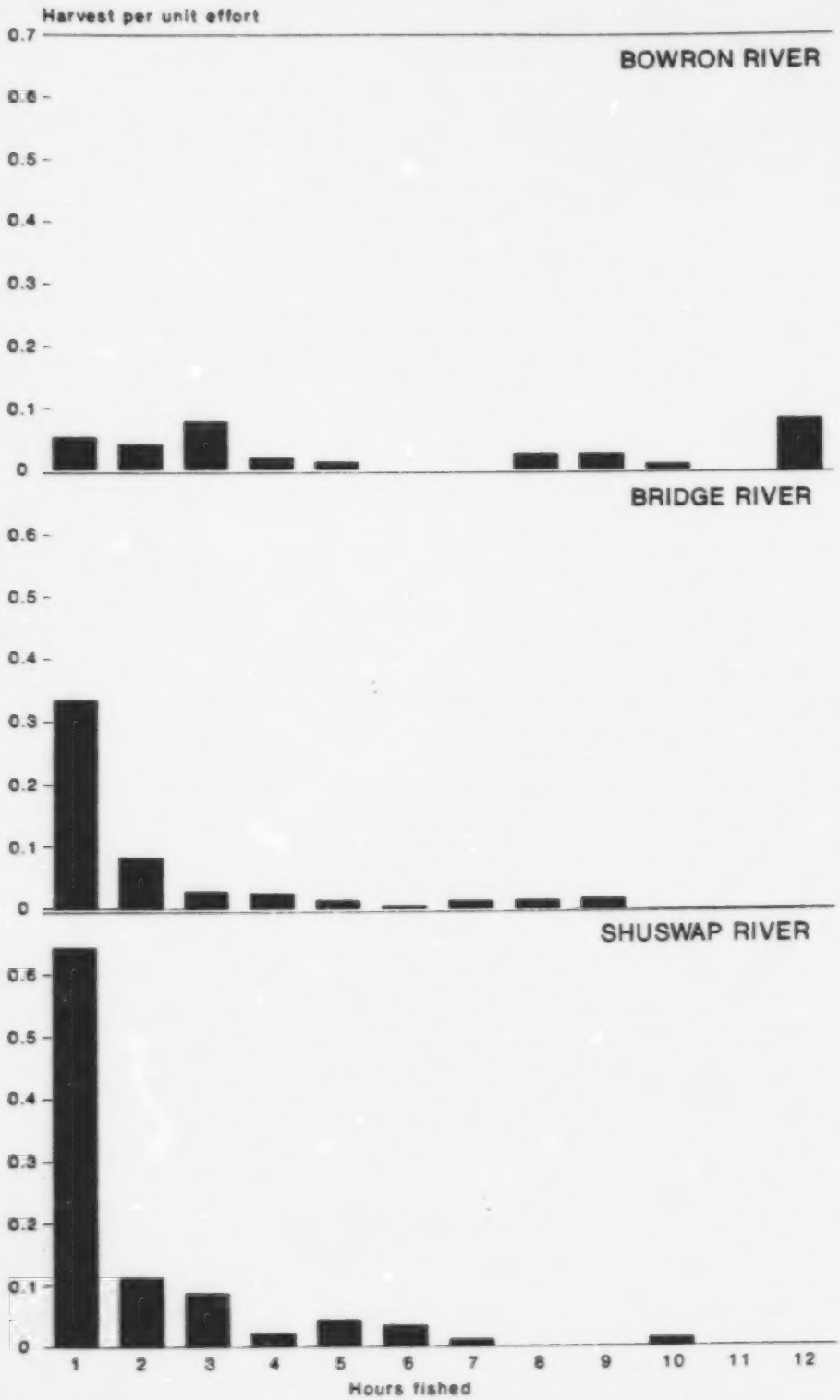


Fig. 7. Harvest per unit effort of chinook adults, by angler trip duration, in four upper Fraser River sport fisheries.

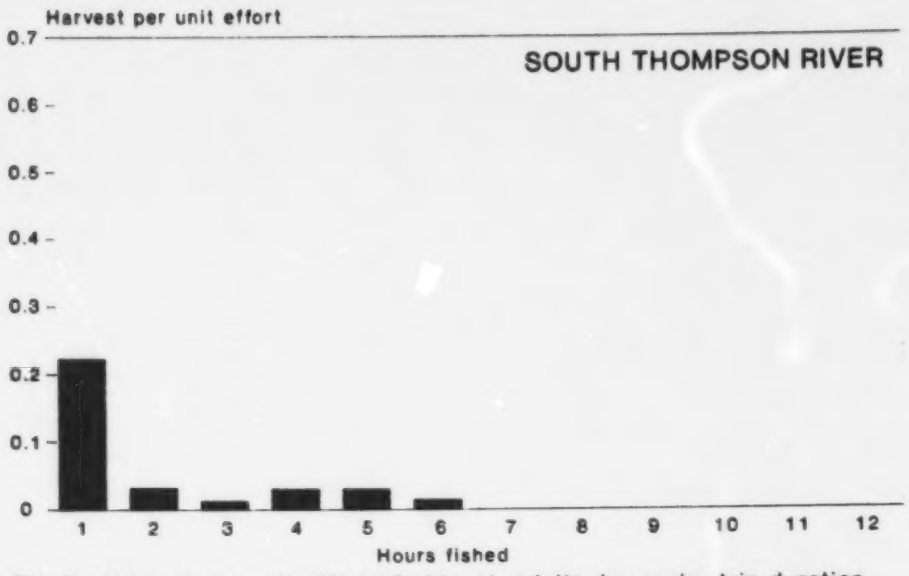


Fig. 7. Harvest per unit effort of chinook adults, by angler trip duration, in four upper Fraser River sport fisheries continued.

that: a) roving surveys be avoided, when possible; b) when unavoidable, roving surveys record the actual time the angler's trip started rather than rounding to the nearest half hour; and c) this bias be further evaluated in a second census of the Bridge River sport fishery.

4. Structured fishery assessment studies should continue in the following areas: Bowron River, because of the changes in fishery performance over the two year study; Bridge River, because of the effectiveness of the fishery and the opportunity for bias assessment; Shuswap River, because of the effectiveness of the fishery; and South Thompson River, because only one year of assessment data is available. Because of the ineffectiveness of the lower Quesnel River fishery, further intensive assessment will not be required until fishery performance improves.

SUMMARY

1. Sport fishery assessment studies were conducted in the Bridge, Bowron, Quesnel, Shuswap and South Thompson rivers in 1987. Each fishery was managed to an individual harvest ceiling through strict regulation of fishing time and daily and annual angler harvest. The Bridge River and South Thompson River fisheries were new fisheries in 1987 while the remainder were opened for the second consecutive year, with fishing times or areas expanded over 1986 in all but the Shuswap River.

2. The fisheries were assessed using a complete census (Bridge River), roving survey (Quesnel River) or hybrid survey (Bowron, Shuswap and South Thompson rivers). The hybrid survey design included both access point and roving surveys.

3. Each fishery was assessed by one to three surveyors, depending on the extent of the open area and the expected angler effort level. The surveyors recorded the following data during 2,001 interviews: length of time angling, target species, number and species of fish harvested or released, identifying marks on harvested fish and gear type.

4. Study area angler effort was estimated at 20,393 angler hours or 4,509 angler days. Of that total, 4,769 hours were spent on the Bowron River, 2,671 at Bridge River, 1,211 on Quesnel River, 6,071 on the Shuswap River and 5,671 on the South Thompson River. Most anglers targeted on chinook salmon.

5. Study area harvest totaled 503 chinook adults, 11 chinook jacks, 126 rainbow trout, 237 Dolly Varden char and 38 whitefish. Of the chinook adult harvest, 121 were from the Bowron River, 115 from Bridge River, 16 from Quesnel River, 215 from Shuswap River and 36 from South Thompson River. Thirty-one Shuswap River chinook adults were marked with an adipose fin clip.

6. Study area release totaled 8 chinook adults, 86 rainbow trout, 3 steelhead trout, 26 Dolly Varden char, 38 whitefish and 10 squawfish. All of the chinook adults were released in the Shuswap River.

7. Harvest rates ranged from 0.18% to 2.10%. The highest harvest rate was recorded in the Shuswap River fishery.

8. The regulation restricting daily angler harvest to a maximum of one chinook salmon resulted in a negative bias in the estimates of HPUE because anglers contacted during their trip had a lower probability of having harvested a chinook salmon than those contacted at the end of their trip. It was recommended that this regulation be relaxed in future years.

9. Over 60% of the interviews recorded during 1987 were excluded from analysis due to the bias noted above. This resulted in a reduction in: 1) estimation precision; 2) the number of sites used to estimate catch; 3) the species diversity in the catch.

10. The complete census at Bridge River identified a potential bias in daily angler effort profiles generated from interview data. Although the bias was not statistically significant, it can result in a substantial underestimate of catch in studies which conduct effort counts during the apparent time of maximum daily angler effort.

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APPENDICES

Appendix 1a. Summary of interview responses by day at Beaver Road Bridge in the 1987 Bowron River sport fishery.

	25-Jul	26-Jul	27-Jul	28-Jul	31-Jul	01-Aug	02-Aug	03-Aug	06-Aug	07-Aug	08-Aug	09-Aug	Total
Number of Interviews	21	10	4	18	9	12	16	14	1	16	5	16	142
Weather a	O	O	O	C	R	R	O	O	C	C	C	O	-
Mean Angler Day Length (hr.)													
- All anglers	4.19	5.60	7.00	4.00	2.44	4.71	4.94	6.93	1.50	2.56	3.80	3.97	4.39
- Complete trip interviews													
Number	6	0	0	16	6	6	10	1	1	9	3	16	74
Hours	2.83	0.00	0.00	3.88	3.17	2.75	5.20	0.50	1.50	1.94	4.33	3.97	3.55
- Incomplete trip interviews													
Number	15	10	4	2	3	6	6	13	0	7	2	0	68
Hours	4.73	5.60	7.00	9.00	1.00	6.67	4.50	7.42	0.00	3.36	3.00	0.00	5.43
Mean number of anglers in party	2.3	2.5	4.0	2.0	2.3	1.7	2.7	2.8	1.0	1.8	1.3	2.3	2.2
Target Species													
- Chinook	12	8	4	10	9	12	10	3	0	7	4	6	85
- Dolly Varden	0	2	0	0	0	0	0	0	0	0	0	0	2
- Anything	9	0	0	8	0	0	6	11	1	9	1	10	55
Harvested Catch													
- Chinook adults	0	0	0	0	0	2	0	0	0	0	1	1	4
- Rainbow	2	0	0	0	0	0	0	0	0	2	0	0	4
- Dolly Varden	1	0	0	0	0	0	0	0	0	0	0	0	1
- Whitefish	1	0	0	0	1	0	0	0	0	2	0	0	4
Released Catch													
- Chinook adults	0	0	0	0	0	0	0	0	0	0	0	0	0
- Rainbow	0	0	0	0	0	0	0	0	0	2	0	0	2
- Whitefish	0	0	0	0	1	3	0	0	0	2	1	0	7
Inspection of Catch													
- Number	0	0	0	0	0	0	0	0	0	0	2	1	3
- Number correct	-	-	-	-	-	-	-	-	-	-	2	1	3
Gear													
- Bait	0	0	0	1	0	0	0	0	0	0	0	0	1
- Lure	20	10	0	9	9	9	12	14	0	10	5	13	111
- Bait/lure	1	0	4	8	0	3	4	0	1	6	0	3	30
- Fly	0	0	0	0	0	0	0	0	0	0	0	0	0

a. C - clear;
O - overcast;

Appendix 1b. Summary of interview responses by day at Hagggen Creek in the 1987 Bowron River sport fishery.

	25-Jul	26-Jul	27-Jul	28-Jul	31-Jul	01-Aug	02-Aug	03-Aug	06-Aug	07-Aug	08-Aug	09-Aug	Total
Number of Interviews	21	18	1	7	8	2	9	8	3	8	10	9	104
Weather a	O	O	O	C	R	R	O	O	C	C	C	O	-
Mean Angler Day Length (hr.)													
- All anglers	11.40	5.33	1.00	5.14	3.44	11.00	9.22	5.94	4.50	2.44	9.00	4.67	5.64
- Complete trip interviews													
Number	9	15	1	5	0	0	6	4	3	7	2	8	60
Hours	7.78	4.70	1.00	5.40	0.00	0.00	7.92	8.50	4.50	2.36	1.00	3.63	4.84
- Incomplete trip interviews													
Number	12	3	0	2	8	2	3	4	0	1	8	1	44
Hours	14.10	8.50	-	4.50	3.44	11.00	11.83	3.38	-	3.00	11.00	13.00	9.68
Mean number of anglers in party	3.0	3.0	1.0	2.0	2.0	2.0	2.0	2.0	1.5	2.0	2.5	3.0	2.4
Target Species													
- Chinook	10	13	1	6	8	2	9	8	3	8	6	9	83
- Rainbow	9	5	0	1	0	0	0	0	0	0	0	0	15
- Anything	2	0	0	0	0	0	0	0	0	0	4	0	6
Harvested Catch													
- Chinook adult	6	2	1	0	1	0	0	0	0	0	0	0	10
- Chinook jack	1	0	0	0	0	0	0	0	0	0	0	0	1
- Rainbow	4	6	0	3	0	0	1	0	0	0	1	0	15
- Dolly Varden	1	0	1	0	0	0	0	0	0	3	0	0	5
- Whitefish	1	1	0	2	0	0	0	0	0	0	0	0	4
Released Catch													
- Chinook	0	0	0	0	0	0	0	0	0	0	0	0	0
- Rainbow	1	7	0	7	0	0	0	0	0	0	0	0	15
- Dolly Varden	6	3	0	0	0	0	0	0	0	0	0	0	9
- Whitefish	0	0	0	1	0	0	0	0	0	0	0	0	1
- Unknown	2	0	0	0	0	0	0	0	0	0	0	0	2
Inspection of Catch													
- Number	8	9	1	0	1	0	1	0	0	2	1	0	23
- Number correct	8	9	1	-	0	-	1	-	-	2	1	-	22
Gear													
- Bait	0	0	0	0	0	0	0	0	0	0	0	0	0
- Lure	21	6	1	6	8	0	4	5	3	6	8	8	76
- Bait/lure	0	12	0	1	0	2	5	3	0	2	2	1	28
- Fly	0	0	0	0	0	0	0	0	0	0	0	0	0

a. C - clear;
O - overcast;

Appendix 1c. Summary of interview responses by day from the roving survey in the 1987 Bowron River sport fishery.

	25-Jul	26-Jul	27-Jul	28-Jul	31-Jul	01-Aug	02-Aug	03-Aug	06-Aug	07-Aug	08-Aug	09-Aug	Total
Number of Interviews	13	14	11	9	7	5	39	25	3	8	11	16	161
Weather a	O	O	O	C	R	R	O	O	C	C	C	O	-
Mean Angler Day Length (hr.)													
- All anglers	5.58	4.96	5.00	3.00	2.43	2.30	5.04	6.84	3.00	2.81	3.77	4.97	4.80
- Complete trip interviews													
Number	10	4	2	0	4	2	19	1	0	1	3	2	48
Hours	6.44	3.00	3.00	0.00	1.25	2.00	4.24	3.00	0.00	1.50	1.67	2.00	3.84
- Incomplete trip interviews													
Number	3	10	9	9	3	3	20	24	3	7	8	14	113
Hours	3.00	5.75	5.44	3.00	4.00	2.50	5.80	7.00	3.00	3.00	4.56	5.39	5.20
Mean number of anglers in party	2.0	2.8	2.2	1.5	1.8	2.5	2.6	2.3	3.0	1 6	1.6	2.3	2.1
Target Species													
- Chinook	9	12	2	8	4	5	35	23	3	6	10	15	132
- Rainbow	0	0	0	0	0	0	2	0	0	0	0	0	2
- Anything	4	2	9	1	3	0	2	2	0	2	1	1	27
Harvested Catch													
- Chinook adult	2	6	0	0	0	0	3	0	0	0	0	0	11
- Rainbow	1	0	0	0	0	0	4	0	0	0	1	2	8
- Dolly Varden	1	0	0	0	0	0	16	0	0	0	1	0	18
- Whitefish	2	0	0	0	0	0	0	0	0	0	0	2	4
Released Catch													
- Chinook	20	0	0	0	0	0	0	0	0	0	0	0	20
- Rainbow	0	0	0	2	0	0	0	0	0	0	1	0	3
- Dolly Varden	2	0	0	0	0	0	0	0	0	0	0	0	2
- Unknown	20	80	0	0	0	0	0	0	0	0	0	0	100
Inspection of Catch													
- Number	0	2	0	0	0	0	2	0	0	0	1	1	6
- Number correct	-	2	-	-	-	-	2	-	-	-	1	1	6
Gear													
- Bait	0	0	0	0	0	0	0	0	0	0	0	1	1
- Lure	13	8	11	9	7	5	39	25	3	8	11	15	154
- Bait/lure	0	6	0	0	0	0	0	0	0	0	0	0	6
- Fly	0	0	0	0	0	0	0	0	0	0	0	0	0

a. C - clear;
O - overcast;
R - rain.

Appendix 2. Daily angler counts by region in the 1987 Bowron River sport fishery.

Date	Time	Region a						Total
		3	4	5	6	7	8	
25-Jul	1300-1359	7	3	13	0	0	15	38
26-Jul	1300-1359	12	1	18	0	0	12	43
27-Jul	1300-1359	10	0	10	0	0	5	25
28-Jul	1300-1359	3	5	1	0	0	10	19
31-Jul	1300-1359	1	0	3	2	0	3	9
01-Aug	1300-1359	6	7	0	7	0	11	31
02-Aug	1300-1359	8	2	10	13	0	14	47
03-Aug	1300-1359	12	6	16	20	0	18	72
06-Aug	1300-1359	0	0	0	5	0	3	8
07-Aug	1300-1359	4	3	0	3	0	3	13
08-Aug	1300-1359	5	4	5	14	0	10	38
09-Aug	1300-1359	6	3	5	4	0	3	21

a. Region 3 - upstream and downstream from Beaver Forest Road Bridge;
4 - immediately downstream from the Highway 16 Bridge;
5 - Highway 16 to Tsus Creek;
6 - Tsus Creek to Spruce Creek;
7 - Spruce Creek to BCFS Campsite;
8 - BCFS Campsite to Haggen Creek boundary.

Appendix 3. Angler effort profiles in the 1987 Bowron, Bridge, Quesnel, South Thompson and lower Shuswap River sport fisheries.

	Bowron River		Bridge River		Quesnel River		Lower Shuswap	South Thompson
Hour	weekday	weekend	Rod count	Interview	weekday	weekend	River	River
100	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000
200	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.000
300	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.000
400	0.000	0.001	0.000	0.000	0.000	0.000	0.022	0.000
500	0.000	0.001	0.000	0.000	0.000	0.000	0.043	0.000
600	0.000	0.002	0.000	0.000	0.000	0.019	0.087	0.044
700	0.010	0.011	0.000	0.000	0.024	0.048	0.096	0.057
800	0.025	0.052	0.095	0.110	0.038	0.058	0.088	0.086
900	0.049	0.058	0.099	0.115	0.066	0.055	0.077	0.095
1000	0.045	0.077	0.109	0.093	0.056	0.058	0.051	0.076
1100	0.089	0.081	0.100	0.078	0.056	0.078	0.031	0.075
1200	0.064	0.090	0.079	0.070	0.042	0.078	0.025	0.072
1300	0.067	0.091	0.072	0.061	0.042	0.081	0.023	0.058
1400	0.067	0.110	0.058	0.061	0.067	0.082	0.033	0.060
1500	0.069	0.092	0.058	0.056	0.088	0.097	0.033	0.072
1600	0.056	0.072	0.062	0.081	0.109	0.086	0.024	0.073
1700	0.066	0.059	0.074	0.094	0.102	0.079	0.037	0.059
1800	0.082	0.059	0.082	0.078	0.085	0.064	0.053	0.061
1900	0.092	0.057	0.073	0.064	0.081	0.056	0.063	0.070
2000	0.119	0.067	0.042	0.039	0.081	0.045	0.057	0.041
2100	0.082	0.014	0.000	0.000	0.032	0.008	0.047	0.000
2200	0.016	0.004	0.000	0.000	0.011	0.003	0.030	0.000
2300	0.000	0.000	0.000	0.000	0.011	0.003	0.023	0.000
2400	0.000	0.000	0.000	0.000	0.011	0.003	0.011	0.000

Appendix 4a. Daily catch per angler hour (harvest and release) in the 1987 Bowron River sport fishery, estimated from complete trip interviews.

	25-Jul	26-Jul	27-Jul	28-Jul	31-Jul	01-Aug	02-Aug	03-Aug	06-Aug	07-Aug	08-Aug	09-Aug	Total a Weekday	Total a Weekend
Harvest per Unit Effort (HPUE)														
Beaver Bridge														
- Chinook adult	0.000	0.000	0.000	0.000	0.000	0.121	0.000	0.000	0.000	0.000	0.077	0.016	0.0000	0.0176
- Rainbow	0.118	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0135
- Dolly Varden	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0067
- Whitefish	0.059	0.000	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0092	0.0067
Haggen Creek														
- Chinook adult	0.043	0.014	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0262	0.0199
- Chinook jack	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0053
- Rainbow	0.029	0.085	0.000	0.111	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0314	0.0243
- Dolly Varden	0.014	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.061	0.000	0.000	0.0437	0.0053
- Whitefish	0.000	0.014	0.000	0.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0210	0.0023
Roving Survey														
- Chinook adult	0.031	0.500	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.0000	0.0512
- Rainbow	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.000	0.000	0.200	0.000	0.0000	0.0346
- Dolly Varden	0.016	0.000	0.000	0.000	0.000	0.000	0.200	0.000	0.000	0.000	0.200	0.000	0.0000	0.1069
- Whitefish	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.1205
Release per Unit Effort (RPUE)														
Beaver Bridge														
- Whitefish	0.000	0.000	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.077	0.000	0.0092	0.0051
Haggen Creek														
- Rainbow	0.071	0.099	0.000	0.259	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0734	0.0159
- Dolly Varden	0.014	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0068
- Whitefish	0.000	0.000	0.000	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0105	0.0000
- Unknown	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0106
Roving Survey														
- Dolly Varden	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0121
- Unknown	0.315	6.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.6024

a. Weighted (see Methods).

Appendix 4b. Daily catch per angler hour (harvest and release) in the 1987 Bowron River sport fishery, estimated from complete and incomplete trip interviews.

	25-Jul	26-Jul	27-Jul	28-Jul	31-Jul	01-Aug	02-Aug	03-Aug	06-Aug	07-Aug	08-Aug	09-Aug	Total a	
													Weekday	Weekend
Harvest per Unit Effort (HPUE)														
Beaver Bridge														
- Chinook adult	0.000	0.000	0.000	0.000	0.000	0.075	0.000	0.000	0.000	0.000	0.071	0.016	0.0000	0.0116
- Rainbow	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.061	0.000	0.000	0.0133	0.0089
- Dolly Varden	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0045
- Whitefish	0.023	0.000	0.000	0.000	0.049	0.000	0.000	0.000	0.000	0.061	0.000	0.000	0.0200	0.0045
Haggen Creek														
- Chinook adult	0.026	0.024	1.000	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0268	0.0170
- Chinook jack	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0024
- Rainbow	0.018	0.071	0.000	0.086	0.000	0.000	0.013	0.000	0.000	0.000	0.033	0.000	0.0193	0.0190
- Dolly Varden	0.004	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.158	0.000	0.000	0.0482	0.0024
- Whitefish	0.004	0.012	0.000	0.057	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0129	0.0034
Roving Survey														
- Chinook adult	0.030	0.179	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.0000	0.0266
- Rainbow	0.015	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.000	0.057	0.036	0.0000	0.0217
- Dolly Varden	0.015	0.000	0.000	0.000	0.000	0.000	0.101	0.000	0.000	0.000	0.057	0.000	0.0000	0.0497
- Whitefish	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.036	0.0000	0.0112
Release per Unit Effort (RPUE)														
Beaver Bridge														
- Rainbow	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.061	0.000	0.000	0.0133	0.0000
- Whitefish	0.000	0.000	0.000	0.000	0.049	0.113	0.000	0.000	0.000	0.061	0.071	0.000	0.0200	0.0134
Haggen Creek														
- Rainbow	0.004	0.083	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0450	0.0095
- Dolly Varden	0.026	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0173
- Whitefish	0.000	0.000	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0064	0.0000
- Unknown	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0047
Roving Survey														
- Rainbow	0.000	0.000	0.000	0.143	0.000	0.000	0.000	0.000	0.000	0.000	0.057	0.000	0.0267	0.0021
- Dolly Varden	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0056
- Unknown	0.602	2.388	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.2800

a. Weighted (see Methods).

Appendix 5. Summary of interview responses by day in the 1987 Bridge River sport fishery.

	12-May	19-May	26-May	02-Jun	09-Jun	16-Jun	18-Jun	23-Jun	25-Jun	30-Jun
Number of Interviews	4	42	81	78	60	43	52	117	72	90
Weather a	O	O	C	C	O	O	C	C	C	C
Mean Angler Day Length (hr.)										
- All anglers	1.00	2.95	3.07	3.13	3.41	3.56	3.55	3.22	2.88	2.94
- Complete trip interviews										
Number	4	42	81	78	60	43	52	117	72	90
Hours	1.00	2.95	3.07	3.13	3.41	3.56	3.55	3.22	2.88	2.94
- Incomplete trip interviews										
Number	0	0	0	0	0	0	0	0	0	0
Hours	-	-	-	-	-	-	-	-	-	-
Mean number of anglers/party	1.33	1.26	1.44	1.46	1.33	1.52	1.33	1.69	1.25	1.54
Target Species										
- Chinook	4	42	81	78	60	43	52	117	72	90
- Anything	0	0	0	0	0	0	0	0	0	0
Harvested Catch										
- Chinook adults	0	11	6	29	0	1	6	19	20	0
- Chinook jacks	0	1	0	1	0	1	0	0	0	0
Released Catch										
- Chinook adults	0	0	0	0	0	0	0	0	0	0
- Chinook jacks	0	0	0	0	0	0	0	0	0	0
- Steelhead	0	3	0	0	0	0	0	0	0	0
Inspection of Catch										
- Number	0	11	6	30	0	2	6	19	20	0
- Number correct	-	11	6	30	-	2	6	19	20	-
Gear										
- Bait	2	37	64	71	47	36	43	110	69	84
- Lure	2	5	11	2	3	1	2	4	0	0
- Bait/lure	0	0	6	5	10	6	7	3	3	6
- Fly	0	0	0	0	0	0	0	0	0	0

a. C - clear;
O - overcast;
R - rain.

Continued

Appendix 5. Summary of interview responses by day in the 1987 Bridge River sport fishery, continued.

	07-Jul	09-Jul	14-Jul	21-Jul	28-Jul	Total
Number of Interviews	30	34	64	60	60	887
Weather a	O	R	C	O	C	-
Mean Angler Day Length (hr.)						
- All anglers	3.37	2.88	3.45	3.23	3.53	3.20
- Complete trip interviews						
Number	30	34	64	60	60	887
Hours	3.37	2.88	3.45	3.23	3.53	3.20
- Incomplete trip interviews						
Number	0	0	0	0	0	0
Hours	-	-	-	-	-	-
Mean number of anglers/party	1.58	1.29	1.49	1.36	1.58	1.44
Target Species						
- Chinook	30	34	64	60	60	887
- Anything	0	0	0	0	0	0
Harvested Catch						
- Chinook adult	0	5	1	3	14	115
- Chinook jack	0	0	0	0	0	3
Released Catch						
- Chinook adult	0	0	0	0	0	0
- Chinook jack	0	0	0	0	0	0
- Steelhead	0	0	0	0	0	3
Inspection of Catch						
- Number	0	5	1	3	14	114
- Number correct	-	5	1	3	14	114
Gear						
- Bait	29	30	56	48	54	780
- Lure	1	1	2	2	0	36
- Bait/lure	0	3	6	10	6	71
- Fly	0	0	0	0	0	0

a. C - clear;
O - overcast;
R - rain.

Appendix 6. Hourly angler counts in the 1987 Bridge River sport fishery.

Hour	19-May	26-May	02-Jun	09-Jun	16-Jun	18-Jun	23-Jun	25-Jun	30-Jun
1200	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0
700	0	0	0	0	0	0	0	0	0
800	9	8	20	26	16	15	30	11	53
900	9	4	20	26	16	15	32	20	53
1000	12	0	15	29	25	19	29	17	51
1100	14	20	11	25	25	17	29	15	40
1200	8	21	11	25	16	18	24	12	26
1300	10	20	10	18	17	12	25	14	17
1400	7	19	10	12	16	11	21	12	16
1500	9	19	14	12	13	10	17	10	17
1600	17	32	11	12	5	12	16	10	7
1700	18	28	13	17	6	18	17	18	11
1800	18	26	32	17	6	23	20	25	9
1900	13	20	36	7	7	9	25	20	10
2000	4	10	15	6	0	8	17	11	4
2100	0	0	0	0	0	0	0	0	0
2200	0	0	0	0	0	0	0	0	0
2300	0	0	0	0	0	0	0	0	0
2400	0	0	0	0	0	0	0	0	0

Continued

Appendix 6. Hourly angler counts in the 1987 Bridge River sport fishery, continued.

Hour	07-Jul	09-Jul	14-Jul	21-Jul	28-Jul	Mean daily rod count	Proportion of mean daily effort
1200	0	0	0	0	0	0	0.000
100	0	0	0	0	0	0	0.000
200	0	0	0	0	0	0	0.000
300	0	0	0	0	0	0	0.000
400	0	0	0	0	0	0	0.000
500	0	0	0	0	0	0	0.000
600	0	0	0	0	0	0	0.000
700	0	0	0	0	0	0	0.000
800	17	9	23	20	16	20	0.095
900	17	11	26	20	16	20	0.099
1000	19	15	35	30	17	22	0.109
1100	13	7	25	31	14	20	0.100
1200	9	6	18	20	12	16	0.079
1300	5	6	18	20	13	15	0.072
1400	4	4	13	8	12	12	0.058
1500	5	5	8	13	13	12	0.058
1600	6	7	10	11	21	13	0.062
1700	4	12	13	11	25	15	0.074
1800	4	10	16	11	17	17	0.082
1900	6	6	19	10	20	15	0.073
2000	5	4	16	9	10	9	0.042
2100	0	0	0	0	0	0	0.000
2200	0	0	0	0	0	0	0.000
2300	0	0	0	0	0	0	0.000
2400	0	0	0	0	0	0	0.000

Appendix 7. Daily catch per angler hour (harvest and release) in the 1987 Bridge River sport fishery.

	12-May	19-May	26-May	02-Jun	09-Jun	16-Jun	18-Jun	23-Jun	25-Jun	30-Jun
Harvest per Unit Effort (HPUE)										
- Chinook adults	0.000	0.082	0.025	0.120	0.000	0.007	0.033	0.051	0.098	0.000
- Chinook jacks	0.000	0.008	0.000	0.004	0.000	0.007	0.000	0.000	0.000	0.000
Release per Unit Effort (RPUE)										
- Steelhead	0.000	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Continued

Appendix 7 continued.

	07-Jul	09-Jul	14-Jul	21-Jul	28-Jul	Total
Harvest per Unit Effort (HPUE)						
- Chinook adults	0.000	0.051	0.005	0.015	0.066	0.0431
- Chinook jacks	0.000	0.000	0.000	0.000	0.000	0.0011
Release per Unit Effort (RPUE)						
- Steelhead	0.000	0.000	0.000	0.000	0.000	0.0011

Appendix 8. Mean mid-fork length and weight, by flesh colour, age and sex, of chinook salmon harvested in the 1987 Bridge River sport fishery.

			Male				Female				Total			
Date	Flesh color	Age	No.	%	Mean length (cm)	Mean weight (kg)	No.	%	Mean length (cm)	Mean weight (kg)	No.	%	Mean length (cm)	Mean weight (kg)
19-May	Red	5/2	1	14.3	76.0	5.4	1	14.3	84.5	7.0	2	28.6	80.3	6.2
		4/2	3	42.9	58.3	2.5	1	14.3	84.0	7.3	4	57.1	64.7	3.7
		3/2	1	14.3	33.0	0.5	0	0.0	-	-	1	14.3	33.0	0.5
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	3	-	95.0	4.4	2	-	81.8	6.7	5	-	89.7	5.3
		Total	8	-	71.1	3.3	4	-	83.0	6.9	12	-	75.1	4.5
26-May	Red	5/2	0	0.0	-	-	2	33.3	87.5	7.3	2	33.3	87.5	7.3
		4/2	4	66.7	62.4	2.6	0	0.0	-	-	4	66.7	62.4	2.6
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	0	-	-	-	0	-	-	-	0	-	-	-
		Total	4	-	62.4	2.6	2	-	87.5	7.3	6	-	70.8	4.2
02-Jun	Red	5/2	2	10.5	89.0	7.7	9	47.4	85.4	7.1	11	57.9	86.1	7.2
		4/2	6	31.6	64.8	4.7	0	0.0	-	-	6	31.6	64.8	4.7
		3/2	1	5.3	40.0	0.6	0	0.0	-	-	1	5.3	40.0	0.6
		3/1	1	5.3	64.0	2.5	0	0.0	-	-	1	5.3	64.0	2.5
		Unknown	4	-	72.1	4.6	7	-	81.9	6.4	11	-	78.3	5.7
		Total	14	-	68.5	4.7	16	-	83.9	6.8	30	-	76.7	5.8
16-Jun	Red	5/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		4/2	1	50.0	71.5	3.9	0	0.0	-	-	1	50.0	71.5	3.9
		3/2	1	50.0	39.0	1.1	0	0.0	-	-	1	50.0	39.0	1.1
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	0	-	-	-	0	-	-	-	0	-	-	-
		Total	2	-	55.3	2.5	0	-	-	-	2	-	55.3	2.5
18-Jun	Red	5/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		4/2	3	100.0	66.0	3.0	0	0.0	-	-	3	100.0	66.0	3.0
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	2	-	92.5	8.6	1	-	95.0	8.2	3	-	93.3	8.5
		Total	5	-	76.6	5.2	1	-	95.0	8.2	6	-	79.7	5.7
23-Jun	Red	5/2	1	9.1	98.0	12.2	3	27.3	85.3	8.3	4	36.4	88.5	9.3
		4/2	6	54.5	69.3	4.5	0	0.0	-	-	6	54.5	69.3	4.5
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	1	9.1	68.5	4.5	0	0.0	-	-	1	9.1	68.5	4.5
		Unknown	3	-	85.3	9.8	5	-	85.0	8.2	8	-	85.1	8.8
		Total	11	-	76.2	6.6	8	-	85.1	8.2	19	-	80.0	7.3
25-Jun	Red	5/2	3	27.3	97.3	11.8	4	36.4	90.4	8.8	7	63.6	93.4	10.1
		4/2	4	36.4	69.0	4.3	0	0.0	-	-	4	36.4	69.0	4.3
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	5	-	91.6	9.4	4	-	86.0	6.9	9	-	89.1	8.3
		Total	12	-	85.5	8.3	8	-	88.2	7.9	20	-	86.6	8.1

Appendix 8. Mean nose-fork length and weight, by flesh colour, age and sex, of chinook salmon harvested in the 1987 Bridge River sport fishery.

			Male				Female				Total			
Date	Flesh color	Age	No.	%	Mean length (cm)	Mean weight (kg)	No.	%	Mean length (cm)	Mean weight (kg)	No.	%	Mean length (cm)	Mean weight (kg)
09-Jul	Red	5/2	1	100.0	100.0	11.8	0	0.0	-	-	1	100.0	100.0	11.8
		4/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	4	-	66.4	6.9	0	-	-	-	4	-	66.4	6.9
		Total	5	-	73.1	7.9	0	-	-	-	5	-	73.1	7.9
14-Jul	Red	5/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		4/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	0	-	-	-	1	-	91.5	11.3	1	-	91.5	11.3
		Total	0	-	-	-	1	-	91.5	11.3	1	-	91.5	11.3
21-Jul	Red	5/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		4/2	1	100.0	70.0	5.0	0	0.0	-	-	1	100.0	70.0	5.0
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	0	-	-	-	0	-	-	-	0	-	-	-
		Total	1	-	70.0	5.0	0	-	-	-	1	-	70.0	5.0
	White	5/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		4/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	1	-	79.0	6.4	1	-	92.0	13.2	2	-	85.5	9.8
		Total	1	-	79.0	6.4	1	-	92.0	13.2	2	-	85.5	9.8
	Total		2	-	74.5	5.7	1	-	92.0	13.2	3	-	80.3	8.2
28-Jul	Red	5/2	1	8.3	99.0	11.8	6	50.0	90.8	9.3	7	58.3	92.0	9.7
		4/2	1	8.3	76.0	5.0	0	0.0	-	-	1	8.3	76.0	5.0
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	1	-	78.0	6.8	0	-	-	-	1	-	78.0	6.8
		Total	3	-	84.3	7.9	6	-	90.8	9.3	9	-	88.6	8.8
	White	5/2	2	16.7	98.0	14.3	2	16.7	94.5	11.6	4	33.3	96.3	13.0
		4/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	1	-	102.0	11.1	0	-	-	-	1	-	102.0	11.1
		Total	3	-	99.3	13.2	2	-	94.5	11.6	5	-	97.4	12.6
	Total		6	-	91.8	10.6	8.0	-	91.7	9.9	14.0	-	91.8	10.2
Total	Red	5/2	9	12.3	93.7	10.2	25	34.2	87.6	8.1	34	46.6	89.2	8.6
		4/2	29	39.7	66.2	3.9	1	1.4	84.0	7.3	30	41.1	66.8	4.0
		3/2	3	4.1	37.3	0.7	0	0.0	-	-	3	4.1	37.3	0.7
		3/1	2	2.7	66.3	3.5	0	0.0	-	-	2	2.7	66.3	3.5
		Unknown	22	-	82.5	7.3	20	-	84.6	7.3	42	-	83.5	7.3
		Total	65	-	74.2	5.8	46	-	86.2	7.7	111	-	79.2	6.6

Appendix 8. Mean nose-fork length and weight, by flesh colour, age and sex, of chinook salmon harvested in the 1987 Bridge River sport fishery.

			Male				Female				Total			
Date	Flesh color	Age	No.	%	Mean length (cm)	Mean weight (kg)	No.	%	Mean length (cm)	Mean weight (kg)	No.	%	Mean length (cm)	Mean weight (kg)
	White	5/2	2	2.7	98.0	14.3	2	2.7	94.5	11.6	4	5.5	96.3	13.0
		4/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/2	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		3/1	0	0.0	-	-	0	0.0	-	-	0	0.0	-	-
		Unknown	2	-	90.5	8.8	1	-	92.0	13.2	3	-	91.0	10.2
		Total	4	-	94.3	11.5	3		93.7	12.1	7	-	94.0	11.8
	Total		69	-	75.4	6.1	49	-	86.7	8.0	118	-	80.1	6.9

Appendix 9. Summary of interview responses by day from the roving survey of the 1987 lower Quesnel River sport fishery.

	14-Jul	18-Jul	21-Jul	25-Jul	28-Jul	01-Aug	04-Aug	08-Aug	11-Aug	15-Aug	Total
Number of Interviews	0	2	13	11	4	8	5	9	13	9	74
Weather a	-	C	O	R	C	R	R	C	O	O	-
Mean Angler Day Length (hr.)											
- All anglers	-	7.75	7.85	9.23	8.00	5.13	4.20	8.33	5.08	10.78	7.45
- Complete trip interviews											
Number	0	0	0	2	0	1	3	3	5	0	14
Hours	-	0.00	0.00	12.00	0.00	2.00	3.00	7.66	3.60	0.00	5.43
- Incomplete trip interviews											
Number	0	2	13	9	4	7	2	6	8	9	60
Hours	-	7.75	7.85	8.61	8.00	5.57	6.00	8.67	6.00	10.78	7.92
Mean number of anglers per party	-	2.0	3.3	3.3	1.3	2.7	2.5	1.5	2.2	2.3	2.4
Target Species											
- Chinook	0	2	8	11	2	6	5	9	13	9	65
- Rainbow or Dolly Varden	0	0	5	0	1	2	0	0	0	0	8
- Dolly Varden	0	0	0	0	1	0	0	0	0	0	1
Harvested Catch											
- Chinook adult	0	0	0	0	0	1	0	0	0	0	1
- Rainbow	0	0	0	0	1	0	0	0	0	0	1
- Whitefish	0	0	1	0	0	0	0	0	0	0	1
Released Catch											
- Chinook adult	0	0	0	0	0	0	0	0	1	0	1
Inspection of Catch											
- Number	0	0	1	0	1	1	0	0	1	0	4
- Number correct	-	-	1	-	0	1	-	-	1	-	3
Gear											
- Bait	0	0	2	1	3	2	0	1	0	0	9
- Lure	0	2	2	5	1	6	5	5	12	4	42
- Bait/lure	0	0	6	5	0	0	0	3	0	5	19
- Fly	0	0	3	0	0	0	0	0	1	0	4

a. C - clear;
O - overcast;
R - rain.

Appendix 10. Daily angler counts in the 1987 lower Quesnel River sport fishery.

Date	Time	Region a						Total
		1	2	3	4	5	6	
July 14	1400-1530	-	-	-	-	-	-	7
July 18	0800-0959	0	3	2	0	0	0	5
July 21	0920-1055	0	3	2	0	1	3	9
July 25	1300-1459	0	2	3	0	2	9	16
July 28	1430-1550	0	2	4	0	0	1	7
Aug 1	1135-1259	0	0	2	0	5	0	7
Aug 4	1100-1259	0	0	0	0	0	3	3
Aug 8	1430-1551	0	5	4	0	2	9	20
Aug 11	1300-1459	0	0	0	0	1	3	4
Aug 15	0900-1059	0	2	0	0	2	5	9

a. Regions were:
1 - Quesnel River mouth to km 7.5;
2 - km 7.5 to km 13.6;
3 - km 13.6 to Deacon Creek;
4 - Deacon Creek to Little Canyon;
5 - Little Canyon to the upper end of Sardine Flats;
6 - Sardine Flats to Beaver Creek.

Appendix 11a. Daily catch per angler hour (harvest and release) in the 1987 lower Quesnel River sport fishery, estimated from complete trip interviews.

	18-Jul	21-Jul	25-Jul	28-Jul	01-Aug	04-Aug	08-Aug	11-Aug	15-Aug	Total
Harvest per Unit Effort (HPUE)										
- Chinook a	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.0204

a. Daily CPUE estimated from interviews; totals weighted (see Methods).

Appendix 11b. Daily catch per angler hour (harvest and release) in the 1987 lower Quesnel River sport fishery, estimated from complete and incomplete trip interviews.

	18-Jul	21-Jul	25-Jul	28-Jul	01-Aug	04-Aug	08-Aug	11-Aug	15-Aug	Total
Harvest per Unit Effort (HPUE)										
- Chinook a	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.000	0.0036
- Rainbow	0.000	0.000	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.0036
- Whitefish	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0036
Release per Unit Effort (RPUE)										
- Chinook a	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.0036

a. Daily CPUE estimated from interviews; totals weighted (see Methods).

Appendix 12a. Summary of interview responses by day at Chuck's Pool in the 1987 lower Shuswap River sport fishery.

	01-Sep	04-Sep	08-Sep	11-Sep	15-Sep	18-Sep	22-Sep	Total
Number of Interviews	41	26	31	33	27	35	27	220
Weather a	C	C	C	C	O	C	C	-
Mean Angler Day Length (hr.)								
- All anglers	4.79	5.00	6.31	5.41	4.39	5.69	4.85	5.22
- Complete trip interviews								
Number	30	11	18	22	20	23	17	141
Hours	4.08	4.59	6.11	4.36	2.98	5.43	3.18	4.38
- Incomplete trip interviews								
Number	11	15	13	11	7	12	10	79
Hours	6.73	5.30	6.58	7.50	8.43	6.17	7.70	6.73
Mean number of anglers per party	1.70	2.00	1.72	1.83	1.56	1.84	1.35	1.70
Target Species								
- Chinook	41	16	31	33	27	33	27	208
- Rainbow	0	10	0	0	0	2	0	12
Harvested Catch								
- Chinook adult	5	0	0	4	4	2	4	19
- Chinook adult, clipped	0	0	0	0	2	0	2	4
- Chinook jack	0	0	0	0	1	0	0	1
- Rainbow	0	0	0	0	0	1	0	1
- Squawfish	0	1	0	0	0	0	0	1
Released Catch								
- Chinook	0	0	0	1	0	0	0	1
- Rainbow	0	1	0	0	0	0	0	1
- Whitefish	0	1	0	0	0	0	0	1
- Squawfish	0	0	1	0	0	0	0	1
Inspection of Catch								
- Number	3	0	0	4	7	2	6	22
- Number correct	3	-	-	4	7	2	6	22
Gear								
- Bait	8	3	4	5	14	17	12	63
- Lure	19	7	8	10	7	2	8	61
- Bait/lure	14	13	19	18	6	16	7	93
- Fly	0	3	0	0	0	0	0	3

a. C - Clear;
O - Overcast;
R - rain.

Appendix 12b. Summary of interview responses by day from the roving survey of the 1987 lower Shuswap River sport fishery.

	01-Sep	04-Sep	08-Sep	11-Sep	15-Sep	18-Sep	22-Sep	Total
Number of Interviews	31	26	26	23	8	17	13	144
Weather a	C	C	C	C	O	C	C	-
Mean Angler Day Length (hr.)								
- All anglers	7.35	7.42	7.02	7.17	5.88	5.59	4.62	6.74
- Complete trip interviews								
Number	4	3	2	1	1	0	4	15
Hours	3.25	6.50	7.00	5.00	2.00	0.00	2.88	4.33
- Incomplete trip interviews								
Number	27	23	24	22	7	17	9	129
Hours	7.96	7.54	7.02	7.27	6.43	5.59	5.39	7.02
Mean number of anglers per party	1.94	1.63	1.86	1.53	1.60	1.70	1.63	1.71
Target Species								
- Chinook	29	20	25	22	8	17	12	133
- Rainbow	0	0	1	0	0	0	0	1
- Anything	2	6	0	1	0	0	1	10
Harvested Catch								
- Chinook adult	1	1	0	1	1	0	0	4
Released Catch								
- Chinook adult	0	0	0	0	0	0	0	0
Inspection of Catch								
- Number	1	1	0	1	0	0	0	3
- Number correct	0	1	-	1	-	-	-	2
Gear								
- Bait	11	6	11	10	6	13	7	64
- Lure	17	12	14	11	2	4	6	66
- Bait/lure	3	8	1	1	0	0	0	13
- Fly	0	0	0	1	0	0	0	1

a. C - clear;
O - overcast;
R - rain.

Appendix 13a. Daily angler counts by subareas in the 1987 Shuswap River sport fishery, Mara Lake to Ashton Creek Bridge.

		Mara Lake to Ashton Creek Bridge a				
Date	Time	1	2	3	4	Total
Sept 1	0601-0832	7	6	4	6	23
Sept 4	1800-1835	6	7	7	3	23
Sept 8	1802-1845	5	5	7	6	23
Sept 11	0601-0830	2	12	4	2	20
Sept 15	0603-0828	0	11	2	0	13
Sept 18	1801-2015	6	10	10	0	26
Sept 22	0603-0819	3	1	0	0	4

a. Subareas were: 1 - Mara Lake to Mara Bridge
2 - Mara Bridge to Grinrod
3 - Grinrod Bridge to Enderby Bridge
4 - Enderby Bridge to Ashton Creek Bridge

Appendix 13b. Daily angler counts by subarea in the 1987 Shuswap River sport fishery, Ashton Creek to Mabel Lake.

		Region a					
Date	Time	1	2	3	4	5b	Total
Sept 1	0601-0832	16	51	2	4	39	112
Sept 4	1835-1946	17	22	4	7	26	76
Sept 8	1846-1950	17	25	4	6	25	77
Sept 11	0601-0830	13	11	1	0	35	60
Sept 15	0603-0828	15	8	5	0	25	53
Sept 18	1801-2015	18	17	1	0	14	50
Sept 22	0603-0819	10	10	0	0	22	42

a. Subareas were: 1 - Ashton Creek Bridge to Fall Creek
2 - Fall Creek to Crook Creek
3 - Crook Creek to Delorne Creek
4 - Delorne Cr. to Skookumchuck
5 - Skookumchuck to Mabel Lake

b. Includes Chuck's Pool

Appendix 14a. Daily catch per angler hour (harvest and release) in the 1987 lower Shuswap River sport fishery, estimated from complete trip interviews.

	01-Sep	04-Sep	08-Sep	11-Sep	15-Sep	18-Sep	22-Sep	Total a
Harvest per Unit Effort (HPUE)								
Chuck's Pool								
- Chinook adults	0.040	0.000	0.000	0.031	0.067	0.016	0.071	0.0281
- Chinook adults, clipped	0.000	0.000	0.000	0.010	0.034	0.000	0.036	0.0051
- Chinook jacks	0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.0014
- Rainbow	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.0019
Roving Survey								
- Chinook adults	0.077	0.051	0.000	0.200	0.500	0.000	0.000	0.0569
Release per Unit Effort (RPUE)								
Chuck's Pool								
- Chinook adults	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.0014
- Rainbow	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.0019
- Squawfish	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.0019

a. Weighted (see Methods).

Appendix 14b. Daily catch per angler hour (harvest and release) in the 1987 lower Shuswap River sport fishery, estimated from complete and incomplete trip interviews.

	01-Sep	04-Sep	08-Sep	11-Sep	15-Sep	18-Sep	22-Sep	Total a
Harvest per Unit Effort (HPUE)								
Chuck's Pool								
- Chinook adults	0.032	0.000	0.000	0.021	0.038	0.012	0.046	0.0169
- Chinook adults, clipped	0.000	0.000	0.000	0.007	0.019	0.000	0.023	0.0035
- Chinook jacks	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.0009
- Rainbow	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.0012
- Squawfish	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.0012
Roving Survey								
- Chinook adults	0.007	0.007	0.000	0.014	0.038	0.000	0.000	0.0064
Release per Unit Effort (RPUE)								
Chuck's Pool								
- Chinook adults	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.0009
- Rainbow	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.0012
- Whitefish	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.0012
- Squawfish	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.0012

a. Weighted (see Methods).

Appendix 15a. Summary of interview responses by day at Banana Island in the 1987 South Thompson River sport fishery.

	11-Sep	15-Sep	18-Sep	22-Sep	25-Sep	Total
Number of Interviews	10	25	17	17	12	81
Weather a	C	C	C	C	C	-
Mean Angler Day Length (hr.)						
- All anglers	3.05	4.58	4.85	4.85	3.21	4.30
- Complete trip interviews						
Number	10	16	17	11	9	63
Hours	3.05	3.66	4.85	5.59	3.17	4.15
- Incomplete trip interviews						
Number	0	9	0	6	3	18
Hours	0.00	6.22	0.00	3.50	3.33	4.83
Mean number of anglers per party	1.2	1.3	1.4	1.6	1.3	1.4
Target Species						
- Chinook	10	24	15	14	10	73
- Anything	0	2	2	3	2	9
Harvested Catch						
- Chinook adult	1	1	0	0	0	2
Released Catch						
- Chinook adult	0	0	0	0	0	0
Inspection of Catch						
- Number	1	1	0	0	0	2
- Number correct	1	1	-	-	-	2
Gear						
- Bait	0	0	0	9	7	16
- Lure	9	24	17	8	5	63
- Bait/lure	1	0	0	0	0	1
- Fly	0	1	0	0	0	1

a. C - clear.

Appendix 15b. Summary of interview responses by day from the roving survey of the 1987 South Thompson River sport fishery.

	11-Sep	15-Sep	18-Sep	22-Sep	25-Sep	Total
Number of Interviews	29	33	40	51	35	188
Weather a	C	C	C	C	C	-
Mean Angler Day Length (hr.)						
- All anglers	3.81	6.25	6.44	6.40	8.20	6.32
- Complete trip interviews						
Number	10	5	6	1	5	27
Hours	2.70	3.90	4.33	2.00	2.50	3.22
- Incomplete trip interviews						
Number	19	28	34	50	30	161
Hours	4.39	6.68	6.81	6.49	9.15	6.84
Mean number of anglers per party	1.9	1.6	1.9	1.8	2.1	1.8
Target Species						
- Chinook	27	24	21	23	35	130
- Anything	2	9	19	28	0	58
Harvested Catch						
- Chinook adult	3	2	2	0	0	7
- Rainbow	0	1	0	3	0	4
- Squawfish	0	1	0	0	0	1
Released Catch						
- Chinook adult	0	0	1	0	0	1
- Chinook jack	0	1	0	0	0	1
- Whitefish	0	2	0	0	0	2
Inspection of Catch						
- Number	3	4	3	3	0	13
- Number correct	3	4	3	3	-	13
Gear						
- Bait	8	2	4	14	7	35
- Lure	21	27	36	37	28	149
- Bait/lure	0	4	0	0	0	4
- Fly	0	0	0	0	0	0

a. C - clear.

Appendix 16. Daily angler counts by region in the 1987 South Thompson River sport fishery.

Date	Time	Region a				Total
		1	2	3 b	4	
Sept 11	0601-0700	12	3	41	7	63
Sept 15	1801-1900	11	2	40	8	61
Sept 18	0701-0800	6	0	80	1	87
Sept 22	0701-0800	5	0	44	12	61

a. Regions were: 1 - Chase to Shuswap;
2 - Shuswap to Niskanlith Creek;
3 - Niskanlith Creek to the bluffs;
4 - Bluffs to Prichard.

b. Includes Banana Island.

Appendix 17a. Daily catch per angler hour (harvest and release) in the 1987 South Thompson River sport fishery, estimated from complete trips.

	11-Sep	15-Sep	18-Sep	22-Sep	25-Sep	Total a
Harvest per Unit Effort (HPUE)						
Banana Island						
Chinook adult	0.033	0.017	0.000	0.000	0.000	0.0055
Roving Survey						
Chinook adult	0.037	0.103	0.077	0.000	0.000	0.0594

a. Weighted (see Methods).

Appendix 17b. Daily catch per angler hour (harvest and release) in the 1987 South Thompson River sport fishery, estimated from complete and incomplete trip interviews.

	11-Sep	15-Sep	18-Sep	22-Sep	25-Sep	Total a
Harvest per Unit Effort (HPUE)						
Banana Island						
Chinook adult	0.033	0.009	0.000	0.000	0.000	0.0066
Roving Survey						
Chinook adult	0.039	0.015	0.015	0.000	0.000	0.0103
Rainbow	0.000	0.007	0.000	0.027	0.000	0.0058
Squawfish	0.000	0.007	0.000	0.000	0.000	0.0014
Release per Unit Effort (RPUE)						
Roving Survey						
Chinook adult	0.000	0.000	0.008	0.000	0.000	0.0014
Chinook jack	0.000	0.007	0.000	0.000	0.000	0.0014
Whitefish	0.000	0.015	0.000	0.000	0.000	0.0029

Appendix 18a. Number of anglers interviewed, total angler effort, chinook adult harvest and HPUE by trip duration in the 1987 Bowron River sport fishery. a

Angler day length (hour)	Angler interviews		Angler effort		Chinook adult harvest		Chinook adult HPUE
	No.	%	Hours	%	No.	%	
0 - 1.0	24	13.2	18.5	2.5	1	5.0	0.0541
1.1 - 2.0	33	18.1	46.5	6.4	2	10.0	0.0430
2.1 - 3.0	44	24.2	126.0	17.3	10	50.0	0.0794
3.1 - 4.0	13	7.1	49.5	6.8	1	5.0	0.0202
4.1 - 5.0	15	8.2	72.5	10.0	1	5.0	0.0138
5.1 - 6.0	18	9.9	108.0	14.9	0	0.0	0.0000
6.1 - 7.0	8	4.4	54.5	7.5	0	0.0	0.0000
7.1 - 8.0	9	4.9	72.0	9.9	2	10.0	0.0278
8.1 - 9.0	4	2.2	36.0	5.0	1	5.0	0.0278
9.1 - 10.0	10	5.5	98.0	13.5	1	5.0	0.0102
10.1 - 11.0	3	1.6	33.0	4.5	0	0.0	0.0000
11.1 - 12.0	1	0.5	12.0	1.7	1	5.0	0.0833
12.1 - 13.0	0	0.0	0.0	0.0	0	0.0	-
13.1 - 14.0	0	0.0	0.0	0.0	0	0.0	-

a. All data are from complete trip interviews.

Appendix 18b. Number of anglers interviewed, total angler effort, chinook adult harvest and HPUE by trip duration in the 1987 Bridge River sport fishery. a

Angler day length (hour)	Angler interviews		Angler effort		Chinook adult harvest		Chinook adult HPUE
	No.	%	Hours	%	No.	%	
0 - 1.0	161	18.2	140.5	5.0	47	40.9	0.3345
1.1 - 2.0	179	20.2	315.5	11.2	26	22.6	0.0824
2.1 - 3.0	230	25.9	636.5	22.6	18	15.7	0.0283
3.1 - 4.0	126	14.2	476.0	16.9	12	10.4	0.0252
4.1 - 5.0	75	8.5	357.0	12.7	5	4.3	0.0140
5.1 - 6.0	35	3.9	201.5	7.2	1	0.9	0.0050
6.1 - 7.0	23	2.6	153.5	5.4	2	1.7	0.0130
7.1 - 8.0	19	2.1	146.5	5.2	2	1.7	0.0137
8.1 - 9.0	14	1.6	123.0	4.4	2	1.7	0.0163
9.1 - 10.0	11	1.2	106.5	3.8	0	0.0	0.0000
10.1 - 11.0	2	0.2	21.0	0.7	0	0.0	0.0000
11.1 - 12.0	12	1.4	140.5	5.0	0	0.0	0.0000
12.1 - 13.0	0	0.0	0.0	0.0	0	0.0	-
13.1 - 14.0	0	0.0	0.0	0.0	0	0.0	-

a. All data are from complete trip interviews.

Appendix 18c. Number of anglers interviewed, total angler effort, chinook adult harvest and HPUE by trip duration in the 1987 lower Shuswap River sport fishery. a

Angler day length (hour)	Angler interviews		Angler effort		Chinook adult harvest		Chinook adult HPUE
	No.	%	Hours	%	No.	%	
0 - 1.0	21	13.6	14.0	2.1	9	31.0	0.6429
1.1 - 2.0	28	18.2	53.5	8.1	6	20.7	0.1121
2.1 - 3.0	21	13.6	57.5	8.7	5	17.2	0.0870
3.1 - 4.0	23	14.9	91.5	13.9	2	6.9	0.0219
4.1 - 5.0	19	12.3	93.0	14.1	4	13.8	0.0430
5.1 - 6.0	5	3.2	29.5	4.5	1	3.4	0.0339
6.1 - 7.0	13	8.4	88.5	13.4	1	3.4	0.0113
7.1 - 8.0	8	5.2	62.5	9.5	0	0.0	0.0000
8.1 - 9.0	1	0.6	9.0	1.4	0	0.0	0.0000
9.1 - 10.0	8	5.2	78.5	11.9	1	3.4	0.0127
10.1 - 11.0	2	1.3	22.0	3.3	0	0.0	0.0000
11.1 - 12.0	5	3.2	60.0	9.1	0	0.0	0.0000
12.1 - 13.0	1	0.6	13.0	2.0	0	0.0	0.0000
13.1 - 14.0	1	0.6	14.0	2.1	0	0.0	0.0000

a. All data are from complete trip interviews.

Appendix 18d. Number of anglers interviewed, total angler effort, chinook adult harvest and HPUE by trip duration in the 1987 South Thompson River sport fishery. a

Angler day length (hour)	Angler interviews		Angler effort		Chinook adult harvest		Chinook adult HPUE
	No.	%	Hours	%	No.	%	
0 - 1.0	5	5.6	4.5	1.4	1	14.3	0.2222
1.1 - 2.0	17	18.9	31.5	9.6	1	14.3	0.0317
2.1 - 3.0	28	31.1	77.0	23.5	1	14.3	0.0130
3.1 - 4.0	9	10.0	33.0	10.1	1	14.3	0.0303
4.1 - 5.0	14	15.6	67.0	20.5	2	28.6	0.0299
5.1 - 6.0	12	13.3	67.5	20.6	1	14.3	0.0148
6.1 - 7.0	2	2.2	14.0	4.3	0	0.0	0.0000
7.1 - 8.0	0	0.0	0.0	0.0	0	0.0	-
8.1 - 9.0	1	1.1	9.0	2.7	0	0.0	0.0000
9.1 - 10.0	0	0.0	0.0	0.0	0	0.0	-
10.1 - 11.0	0	0.0	0.0	0.0	0	0.0	-
11.1 - 12.0	2	2.2	24.0	7.3	0	0.0	0.0000
12.1 - 13.0	0	0.0	0.0	0.0	0	0.0	-
13.1 - 14.0	0	0.0	0.0	0.0	0	0.0	-

a. All data are from complete trip interviews.

Appendix 19. Variance estimation procedure for access point surveys (adapted from DPA Group Inc. (MS 1985a)).

CATCH (C)

$$(1)\ \mathrm{Var}(C) = \bar{c}^2\ E^2 \left[\frac{\mathrm{Var}(E)}{E^2} + \frac{\mathrm{Var}(\bar{c})}{\bar{c}^2} + \frac{\mathrm{Var}(E)\mathrm{Var}(\bar{c})}{\bar{c}^2 E^2} \right]$$

where: E = estimated study period effort (hours),
$\mathrm{Var}(E)$ = variance of the estimated study period effort (see equation 2),
$\bar{c}$ = estimated study period catch per angler hour,
$\mathrm{Var}(\bar{c})$ = variance of the estimated study period catch per angler hour (see equation 3).

EFFORT (E)

$$(2)\ \mathrm{Var}(E) = N^2 \left[\frac{\bar{y}_j^*}{\bar{p}_j^*} \right]^2 \left[\frac{\mathrm{Var}(\bar{y}_j^*)}{\bar{y}_j^{*2}} + \frac{\mathrm{Var}(\bar{p}_j^*)}{\bar{p}_j^{*2}} - \frac{2\ \mathrm{Cov}(\bar{y}_j^*, \bar{p}_j^*)}{(\bar{y}_j^*)(\bar{p}_j^*)} \right]$$

where: N = total days in study period,
$\bar{y}_j^*$ = mean instantaneous rod count (hour j*),
$\mathrm{Var}\ \bar{y}_j^*$ = variance at the mean rod count at hour j* (see equation 4),
$\bar{p}_j^*$ = proportion of daily angler hours occurring at time of instantaneous rod count,
$\mathrm{Var}\ \bar{p}_j^*$ = variance of the proportion of daily angler hours occurring at time of instantaneous rod count (see equation 5).

CATCH PER UNIT EFFORT ($\bar{c}$)

Because $\bar{c}$ is a ratio of catch to time of interview ($\hat{x}$) and time fished to time of interview ($\hat{t}$), a Taylor series approximation to the variance of the ratio of random variables was used. Because we expected to interview a relatively large proportion of the anglers, especially at the access point sites, the greatest variance was expected to occur at the stint level; consequently, the following estimate embodies only that sampling stage.

$$(3)\ \mathrm{Var}(\bar{c}) = \left[\frac{\hat{x}}{\hat{t}} \right]^2 \left[\frac{\mathrm{Var}(\hat{x})}{\hat{x}^2} + \frac{\mathrm{Var}(\hat{t})}{\hat{t}^2} - \frac{2\ \mathrm{Cov}(\hat{x}, \hat{t})}{(\hat{x})(\hat{t})} \right]$$

where:
$$\mathrm{Cov}(\hat{x}, \hat{t}) = \sum_i \sum_l N^2\ (1/n_{ij} - 1/N) \sum_f \left[\frac{(\hat{x}_{ilf}\hat{t}_{ilf}) - 1/n_{ij} \sum_f \hat{x}_{ilf} \sum_i \hat{t}_{ilf}}{n_{ij} - 1} \right]$$

$$\mathrm{Var}(\hat{x}) = \sum_i \sum_l N^2\ (1/n_{ij} - 1/N) \sum_f \left[\frac{(\hat{x}_{ilf} - (1/n_{ij} \sum_f \hat{x}_{ilf}))^2}{n_{ij} - 1} \right]$$

$\mathrm{Var}(\hat{t})$ is analogous to above.

$\hat{X}_{ilf}$ = estimated total catch for the f^{th} stint of the l^{th} stint type at the i^{th} site,

$\hat{T}_{ilf}$ = estimated total angler hours for the f^{th} stint of the l^{th} stint type at the i^{th} site,

n_{ij} = number of interview sample days at site i on hour j.

MEAN INSTANTANEOUS ROD COUNT ($\bar{y}_j^*$)

$$(4)\quad \mathrm{Var}(\bar{y}_j^*) = (1/n_j^* - 1/N) \sum_k \left[\frac{(y_j^*{}_k - \bar{y}_j^*)^2}{n_j^* - 1} \right]$$

where: n_j^* = number of instantaneous rod counts at hour j*,

$y_j^*{}_k$ = instantaneous rod count (all sites) on day k,

$\bar{y}_j^*$ = estimated mean rod count at hour j*.

PROPORTION OF DAILY EFFORT AT TIME OF INSTANTANEOUS ROD COUNT ($\bar{p}_j^*$).

Because $\bar{p}_j^*$ is a ratio of $\hat{R}_j^*$ and $\sum R_j$, the following Taylor Series approximation to the variance of the ratio at random variables was used:

$$(5)\quad \mathrm{Var}(\bar{p}_j^*) = \left[\frac{\hat{R}_j^*}{\sum_j \hat{R}_j} \right]^2 \left[\frac{\mathrm{Var}(\hat{R}_j^*)}{\hat{R}_j^{*2}} + \frac{\mathrm{Var} \sum_j \hat{R}_j}{\sum_j \hat{R}_j^2} - \frac{2\ \mathrm{Cov}(\hat{R}_j^*, \sum_j \hat{R}_j)}{(\hat{R}_j^*)\ (\sum_j \hat{R}_j)} \right]$$

where:

$$\mathrm{Cov}(\hat{R}_j^*, \sum_j \hat{R}_j) = \sum_i N^2 (1/n_{ij}^* - 1/N) \sum_k \left[\frac{(r_{ij}^*{}_k \sum_j r_{ijk}) - (1/n_{ij}^* \sum_k r_{ij}^*{}_k \sum_i \sum_j r_{ijk})}{n_{ij}^* - 1} \right]$$

$$\mathrm{Var}(\hat{R}_j^*) = \sum_i N^2 (1/n_{ij}^* - 1/N) \sum_k \left[\frac{(r_{ij}^*{}_k - (1/n_{ij}^* \sum_k r_j^*{}_k))^2}{n_{ij}^* - 1} \right]$$

$\mathrm{Var} \sum_j \hat{R}_j$ is analagous to above.

N = number of days in stratum,

n_{ij}^* = number of interview sample days at site i,

r_{ijk} = rod count at site i at hour j on day k,

$r_{ij}^*{}_k$ = rod count at site i on day k at the hour of the instantaneous effort count,

$\hat{R}_j^*$ = estimated total effort (rod hours) during the instantaneous rod count time block,

$\sum_j \hat{R}_j$ = estimated number of rods hours over all hours and days at the sites surveyed.